Monitor and Protect Wigwam River Bull Trout for Koocanusa Reservoir

Skookumchuck Creek Juvenile Bull Trout and Fish Habitat Monitoring Program

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2002 - 2003

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BONNEVILLE POWER ADMINISTRATION

Skookumchuck Creek Juvenile Bull Trout and Fish Habitat Monitoring Program: 2003 Data Report

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Executive Summary

The Skookumchuck Creek juvenile bull trout (*Salvelinus confluentus*) and fish habitat-monitoring program is a co-operative initiative of the British Columbia Ministry of Water, Land, and Air Protection and Bonneville Power Administration. The objective was to develop a better understanding of juvenile bull trout and Westslope cutthroat trout recruitment and the ongoing hydrologic and morphologic processes, especially as they relate to spawning and rearing habitat quality. This report provides a summary of results obtained to date.

In 2003, several minor modifications were made to the three Skookumchuck Creek index sites permanently established in 2002. Sites one and three were extended by 210 m and 100 m, respectively, and the bankfull height was lowered slightly for all three index sites. These changes resulted in a better fit among index sites between observed bankfull indicators, bankfull cross-sectional area, estimated bankfull discharge and estimated water velocity. However, the 2003 bankfull discharge estimates generated from the estimated cross-sectional area and “roughness” or mannings n were lower than return frequency estimates. This discrepancy was most likely due to a combination of; 1) the actual return frequency was lower than 1.5, and 2) bankfull elevation was under-estimated slightly. A fourth index site was permanently established in Sandown Creek in 2003. This site was added to represent juvenile rearing habitat, within a sub-basin that supports a major proportion of the current forest harvesting activity.

Bull trout represented 49.6% of the juvenile catch in 2003. Although the percentage of the total catch was lower for bull trout in 2003, the total catch of bull trout fry was notably higher and this resulted in higher mean annual density estimates across all index sites. This was especially true for site three, where densities were significantly higher in 2003 (16.4 fish/100 m^2). Higher densities were attributed to improved survival based on the significantly larger size of fry in 2003, and the comparatively warm and dry winter and spring of 2002-2003.

The decrease in catch composition of bull trout in 2003 was due to a corresponding increase in Westslope cutthroat trout catch. Westslope cutthroat trout fry were captured exclusively in sites two and three (the bull trout spawning reaches). The capture of cutthroat trout fry in 2003 but not in 2002 was thought to represent an earlier date of emergence due to warmer water temperatures. Juveniles were captured in all sample sites, however, Sandown Creek captures represented 76.7% of all juvenile captures. The corresponding juvenile Westslope

cutthroat trout density (4.62 fish/100 m^2) was the highest recorded in the bull trout and fish habitat monitoring program.

In 2003, snorkel surveys were conducted on mainstem Skookumchuck Creek index sites to target deep, mid-channel habitat that was not effectively sampled using existing electrofishing techniques. Sub-adult and adult Westslope cutthroat trout dominated this habitat. Densities were 3.1 and 3.2 fish/100 lineal m for sites one and three, respectively, while site two densities were 8.6 fish/100 lineal m. The very high densities of adult cutthroat trout within site two were attributed to habitat quality and in particular, the abundance of deep pool habitat.

The range of morphological stream types for the mainstem Skookumchuck Creek encompass the stable and resilient spectrum (C3(1), C3). In general, Skookumchuck Creek can be characterized by stability and habitat heterogeneity. These reaches, with their high sinuosity, frequent deep pools, and high quality spawning and rearing habitat contain high densities of bull trout and Westslope cutthroat trout. Sandown Creek, in contrast, appears to be undergoing a successional evolution from an F4 stream type to a C4 stream type to accommodate changes or alterations to sediment supply. Disturbance indicators suggest increased sediment supply resulted in channel aggradation and infilling. The previously over-widened bed of the F4 stream type is now the elevation of the new floodplain for the C4 stream type, which gradually incises through the aggraded streambed. Although disturbed, Sandown Creek maintains high habitat value and the high juvenile Westslope cutthroat trout densities can be attributed to the high frequency of large woody debris (LWD) and associated LWD cover in pools.

When compared to other bull trout and Westslope cutthroat trout systems, a strong case can be made that the Skookumchuck Creek bull trout and Westslope cutthroat trout represent a significant and stable population. The upper Skookumchuck Creek watershed remains relatively pristine, and maintains high water quality and high habitat capability. After eighty years of forest development and public access within the Skookumchuck Creek watershed, conservative forest harvesting levels that preserved the riparian ecosystem, and angling regulations designed to limit harvest, appear to have been successful in preventing habitat degradation or over-exploitation of the fishery.

Acknowledgements

The Skookumchuck Creek juvenile bull trout and fish habitat-monitoring program is a trans-boundary initiative implemented by the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), in cooperation with Bonneville Power Administration (BPA). Funding was provided by BPA under the umbrella project "Monitor and Protect Bull Trout for Koocanusa Reservoir"; BPA project Number 2000-004-00. The contribution and on-going monitoring results provided by Herb Tepper, Bill Westover and Kevin Heidt (MWLAP) are acknowledged and greatly appreciated.

Kerry Morris, and Angela Prince of Westslope Fisheries Ltd. contributed to data collection.

R. Lopaschuck (Nanrich Water Management Consultants) provided the 2002 and 2003 Hydrometric Data from the Tembec Inc. Skookumchuck Creek water quantity and water quality inventory program. Barry Benson (Tembec Inc.) provided the harvesting data.

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1 Introduction

This report summarizes the second year of a three year juvenile bull trout (*Salvelinus confluentus*) and fish habitat-monitoring program for Skookumchuck Creek. Skookumchuck Creek is a regionally significant sportfish stream located in southeastern British Columbia that supports healthy populations of both bull trout and Westslope cutthroat trout (Figure 1). Biotelemetry investigations have identified the upper Skookumchuck as an important bull trout-spawning stream in the Kootenay Region (B. Westover, MWLAP, Cranbrook, B.C., *pers. comm*.) and also supports Westslope cutthroat trout (*Oncorhynchus clarki lewisi*). These fish are highly sought after by anglers and commercial guides. The Skookumchuck Creek juvenile bull trout and fish habitat-monitoring program is a trans-boundary initiative implemented by the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), in cooperation with Bonneville Power Administration (BPA).

Bull trout populations have declined in many areas of their range within the Pacific Northwest including British Columbia. Bull trout were blue listed as vulnerable in British Columbia by the B.C. Conservation Data Center (Cannings 1993) and although there are many healthy populations of bull trout in the East Kootenay they remain a species of special concern. Bull trout in the United States portion of the Columbia River were listed as threatened in 1998 under the Endangered Species Act by the U.S. Fish and Wildlife Service. The upper Kootenay River watershed (above Libby Dam) is within the Kootenai sub-basin of the Mountain Columbia Province, one of the eleven Eco-provinces that make up the Columbia River Basin, and has become a primary focus of research for bull trout in both Canada and the United States.

MWLAP applied for and received funding from BPA to assess and monitor the status of wild, native stocks of bull trout in tributaries to Lake Koocanusa (Libby Reservoir) and the upper Kootenay River. The Skookumchuck Creek juvenile bull trout and fish habitat-monitoring program is one of many that were undertaken to "Monitor and Protect Bull Trout for Koocanusa Reservoir" (BPA Project Number 2000-04-00). These include comparative juvenile bull trout and fish habitat studies in the Wigwam River (Cope 2003) and the White River (Cope *in prep*.), adult enumeration projects on the Wigwam River (Baxter and Westover 2000), Skookumchuck Creek (Baxter and Baxter 2002), and the White River (Cope and Morris 2004), as well as an upper Kootenay River basin-wide radio telemetry project (B. Westover, MWLAP, Cranbrook, B.C., *pers. comm*.).

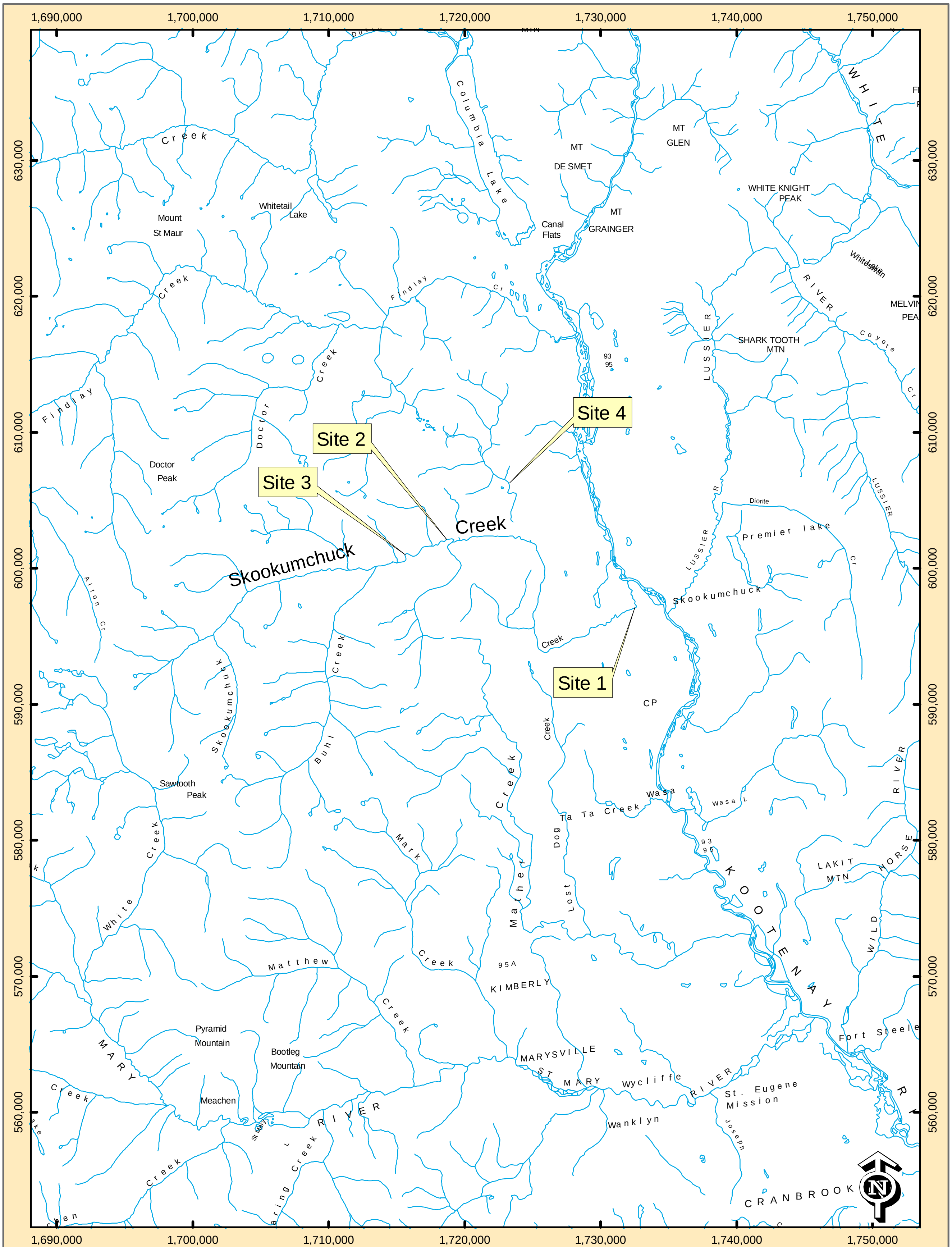

Figure 1 : Overview Map of the Skookumchuck Creek

Date: February 2004
Scale: 1 : 400 000
Drawing: Skookoverview.mxd
Projection: BC Albers - Nad 83 Datum

0 5 10 15 20
Kilometers

1.1 Objectives

At each permanent index site (n=4), over three consecutive years, juvenile fish densities, stream habitat conditions and detailed geomorphic surveys will be documented. The objective of this project is to develop a better understanding of inter-annual variation in juvenile bull trout and Westslope cutthroat trout recruitment and the ongoing hydrologic and morphologic processes in Skookumchuck Creek, especially as they relate to spawning and rearing habitat quality. Data is collected in a compatible manner for companion studies of sympatric fish populations within the Wigwam and White Rivers. The data for these watersheds will contribute to the development of a long-term monitoring and stock assessment program for the upper Kootenay River bull trout and Westslope cutthroat trout populations, that should ensure potential impacts from increased development and angling pressure are minimized.

1.2 Study Area

Skookumchuck Creek originates in the Purcell Mountains within the Purcell Wilderness Conservancy and flows east for 64 km until it empties into the Kootenay River, a tributary to Lake Koocanusa (Figure 1). The headwaters of the Skookumchuck drainage originate at an elevation of approximately 2,250 m and declines to 750 m. The Skookumchuck Creek valley is characterized by five biogeoclimatic zone variants; Kootenay dry mild ponderosa pine, Kootenay dry mild interior Douglas-fir, dry cool montane spruce, dry cool Engelmann spruce sub-alpine fir and alpine tundra (Braumandl and Curran 1992).

The upper reaches of Skookumchuck Creek occupy a narrow alluvial floodplain that is bounded by steep mountain slopes. Immediately below the Buhl Creek confluence an impassable falls limits upstream fish passage and represents the upstream limit to the study area (approximately river km 44). Immediately below the falls, Skookumchuck Creek occupies a narrow, alluvial floodplain associated with channel-confining bedrock outcrops. The combination of frequent lateral migration and erosion of adjacent terraces and coarse sediment delivery to the mainstem river has created a channel comprised of sorted cobbles, gravels and boulders that provide prime spawning and juvenile rearing habitat for bull trout. The occurrence of highly permeable glacial till within adjacent terraces has contributed to a predominance of sub-surface flow that reaches the mainstem as groundwater. The provision of suitably sized bed materials in a low gradient, low water velocity location with associated groundwater have been identified as repeating patterns of preferred bull trout spawning habitat (McPhail and Baxter 1996). At approximately river kilometer 34 Skookumchuck Creek flows through a confined bedrock canyon that flows for approximately 31 kilometers before exiting into the Kootenay River valley, where it flows the final 3 kilometers to the Kootenay River.

Three permanent sampling sites were established in the mainstem Skookumchuck Creek in July 2002. Site 1 was located in the lower river at Skookumchuck, outside the bounds of the “preferred” bull trout spawning and rearing reaches (Appendix A; 1:40,000 TRIM Map). Sites 2 and 3 were located above the Skookumchuck canyon. Site 3 was located in the previously identified “preferred” bull trout spawning reach and site 2 was located immediately downstream of this reach in an area of lower density bull trout spawning (Appendix A; 1:40,000 TRIM Map). In July 2003, a fourth site was established in Sandown Creek. This site was included to represent important tributary spawning and rearing habitat. Sandown Creek also supports a major proportion of the current forest harvesting activity.

Skookumchuck Creek has a total watershed area of approximately 641 km^2. The flow regime of Skookumchuck Creek is comparable to most interior systems with high annual run-off reaching it’s peak in June and expected low flows in late fall and winter (Figure 2). Freeze up generally occurs in mid to late November; however, areas of groundwater infiltration remain open in most years.

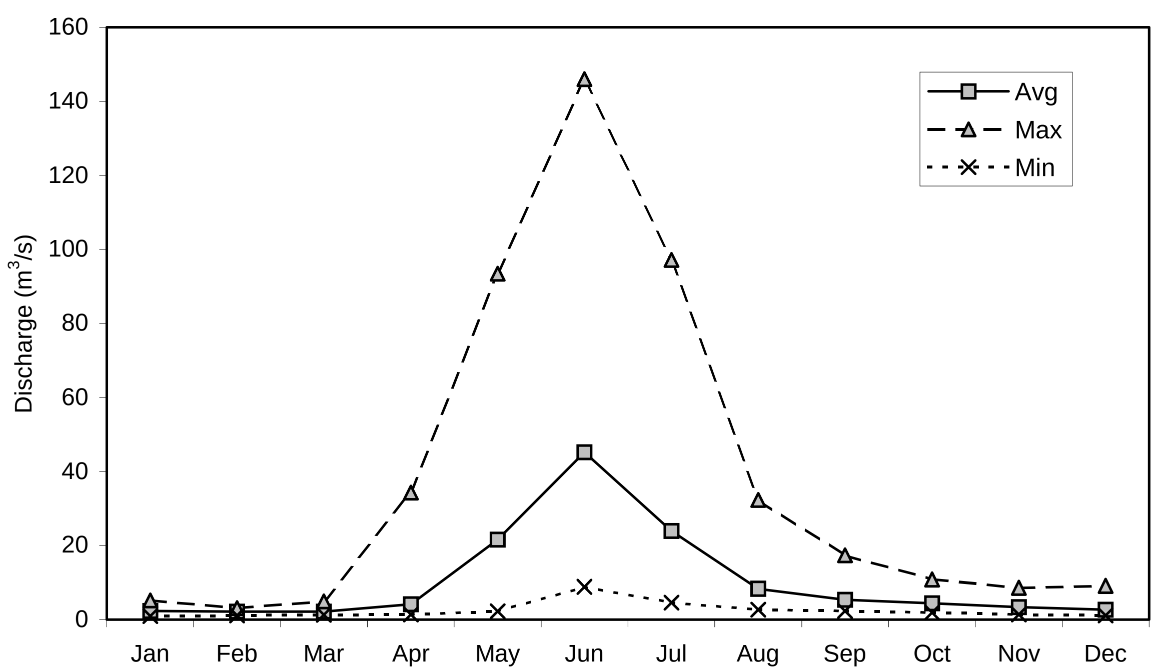

Figure 2. Mean, minimum, and maximum monthly discharge for Skookumchuck Creek near Skookumchuck, 1949 – 1955, 1963-1984 (WSC Stn No. 08NG051).

1.1.1 Forest Harvesting

Forest harvesting and accompanying road development have a long history in the Skookumchuck Creek watershed. Canadian Pacific Railway built and maintained a Skookumchuck camp (Echo Lake) from 1916 to 1930 and the Timberman directory for 1930 listed 180 men (Anon. 2002). The Westcoast Lumberman reported in 1935 that the Crowsnest Pass Lumber Company was building a sawmill at Skookumchuck, and that they expected to cut 15 million feet that season (Anon. 2002). Kootenay Ripples (Anon. 2002) references portable sawmills and camps "up the Skookumchuck" in the 1940's and in 1956 L&Q Lumber Limited bought the logging and sawmill operations up the Skookumchuck River belonging to C. Wenger and family and the camp became "quite a little settlement". To this day, old structures, sawdust piles, wood waste and camp debris still remain from this era of "bush" camps within the watershed. In September of 1968, Tembec Inc. bleached kraft pulp mill started operation at Skookumchuck where it operates today.

Tembec Inc. is the current Forest licensee (F.L. A18978) in the Skookumchuck Creek watershed. The current five-year Forest Development Plan (FDP) was initiated in 2001 and since then 817.7 ha or 196,934.7 m^3 of harvest volume has been logged. In 2002 (Oct. 01 to Sept. 02) a total of 417.3 ha or 123,976 m^3 of harvest volume was logged and in 2003 (Oct. 02 to Sept. 03) a total of 400.4 ha or 98,699.7 m^3 of harvest volume was logged. For the remaining three years of the FDP, a total of 282.8 ha or 72,347.9 m^3 of harvest volume are scheduled for harvest.

1.1.2 Fisheries Resource Status

Provincial management objectives for Skookumchuck Creek are protection of bull trout and Westslope cutthroat trout spawning areas and angler use of wild fish. Bull trout and Westslope cutthroat trout are the primary management species and are highly sought after by local, regional and international anglers. A local commercial guiding industry caters to recreational fishermen targeting these fish.

Bull trout populations have been shown to be extremely susceptible to habitat degradation and over harvest (McPhail and Baxter 1996, Ratliff *et al*. 1996) and are ecologically important as an indicator of watershed health (Baxter 1997). Bull trout are not found in streams where maximum monthly water temperatures exceed 18^{o}C and are most abundant where water temperatures are 12^{o}C or less (Goetz 1989, Ford *et. al.* 1995, McPhail and Baxter 1996, Buchanan and Gregory 1997). This preference for cooler water manifests in the frequent association of bull trout with cold perennial springs (Oliver 1979, Goetz 1989, McPhail and Baxter 1996, Buchanan and Gregory 1997).

When compared to other bull trout systems, the large spawning escapement of upper Kootenay River bull trout provide a strong case that this population may be the most prolific bull trout population in the species distributional range (Figure 3). Wigwam River juvenile bull trout fish and fish habitat studies have demonstrated that this population represents a large and stable population and are ecologically important as an indicator of watershed health. As such, it was concluded that the upper Wigwam River watershed remains relatively pristine, and maintains high water quality, high habitat capability and, conservative angling regulations imposed in the 1990's have been successful in preventing over-exploitation (Cope 2003).

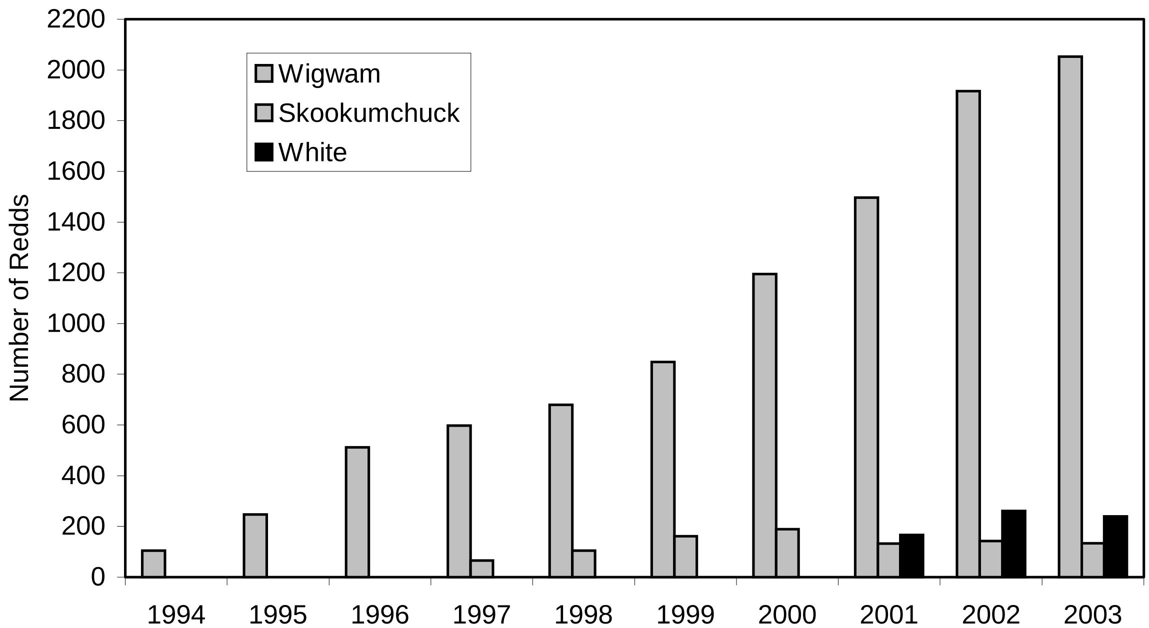

Figure 3. Summary of annual bull trout redd surveys conducted on the three most important upper Kootenay River spawning tributaries identified using radio-telemetry. Note that in 2002 an index site on Blackfoot Creek was added to the annual redd surveys for the White River.

Westslope cutthroat trout are also typical of cold, nutrient poor streams (Liknes and Graham 1988). The Skookumchuck Creek population of Westslope cutthroat trout contains appreciable numbers of large individuals with adults attaining 450 mm fork length. Although the distribution and abundance of Westslope cutthroat trout have drastically declined from its historic range during the last 100 years, the abundance and size of the current Skookumchuck Creek population may be attributed to the combination of special regulations designed to limit harvest and high quality available habitat.

Forest development plans for bull trout spawning and rearing tributaries have come under considerable scrutiny because of potential impacts to bull trout habitat. The issues have largely centered on block size, water temperature, increased sediment yield, and base flow levels in the mainstem river. The creation of extensive openings are intended to mimic a natural stand initiating event consistent with wildfire history. The size and extent of the proposed clear-cuts however, are perceived to alter basin hydrology, affect the annual flow regime (both peak and base flows) and encourage surface erosion that could lead to fine sediment delivery.

Historical stocking of non-indigenous species also represent a concern within Skookumchuck Creek. Brook trout readily hybridize with bull trout and although there are no stocking records for this species they have been identified (FISS 2002). In 1949 a cutthroat/rainbow trout hybrid was stocked in the Skookumchuck and Westslope cutthroat trout eyed eggs or fry were stocked in twelve years between 1942 and 1957(FISS 2002).

2 Methods

Three permanent sampling sites were established in the mainstem Skookumchuck Creek in July 2002. In July 2003, a fourth site was established in the spawning and rearing tributary of Sandown Creek. The UTM coordinates for the upstream and downstream limits of the longitudinal survey, the pool and riffle cross-sectional survey and the electrofishing sample sites were overlain on the digital NAD 83 Forest Cover TRIM Sheet and plotted (Appendix A, 1:40,000 TRIM map).

Sampling sites were a minimum of 20 channel widths in length or a distance equal to two stream meander wavelengths. At each site the following reference points were permanently established, geo-referenced (UTM) and marked with a combination of metal tree tag, tree blaze, fluorescent tree paint, and flagging tape:

- Upstream and downstream elevation benchmarks. Elevation benchmarks were represented by a lag bolt imbedded in the base of a large, stable, riparian tree,
- Upstream and downstream limits of the longitudinal survey,
- Riffle and pool cross-sectional benchmarks (lag bolt imbedded in the base of a riparian tree) and bank “pins” representing the start and finish reference points, and
- Electrofishing habitat units.

The following methods outline the specific assessments completed at each of the four permanently established sites.

2.1 Enumeration

Estimates of juvenile fish density (number of fish/100 m^2) were determined using closed, maximum-likelihood removal estimates (Riley and Fausch 1992). For each site, three habitat units (riffle, pool and glide) were individually sampled for fish densities over a combined total of approximately 100 lineal meters and/or 500 m^2. This methodology allows for habitat unit comparisons as well as reach comparisons through pooling of habitat units to obtain a mean. A Smith-Root Mark 12POW backpack electroshocker was used for successive depletions within each closed sample unit. Although bull trout are the main focus of this project, all captured fish are reported.

Catch results from individual habitat units were summed, by pass, at each representative reach location. These results were then used to estimate the number of fry (0^+ age class) and juveniles (1^+ to 3^+ age classes) within the composite enclosure area. Population estimates were calculated using the "Microfish" software package (Van Deventer and Platts 1990). Population estimates and their 95% confidence interval were then reported as a standard numerical density (number fish/100 m^2) for each site.

During electrofishing surveys, stream discharge was estimated at each location using a Price 1210AA velocity meter and wading rod calibrated bi-annually by the National Calibration Service of the National Water Research Institute.

Westslope cutthroat trout and bull trout greater than 200 mm fork length typically utilize habitat and depths that preclude effective sampling with the electrofishing methods employed in this study (*i.e*. deep pool habitat, mid-channel habitat). Therefore, in 2003, snorkel surveys were conducted within the mainstem Skookumchuck Creek index sites so that the sub-adult and adult life-stages of Westslope cutthroat trout and bull trout could be indexed. For each site, a distance of approximately 1,000 m was snorkeled by a single observer and observations were tallied, by species, in 100 mm size classes. Estimates of sub-adult and adult fish density were then reported as the number of fish/100 lineal m.

2.2 Fish Habitat Assessment

A standard suite of habitat parameters were collected using the Resource Inventory Committee (RIC) approved Fish Habitat Assessment Procedures (FHAP), Level 1, Form 4 - Habitat Survey Data Form (Johnston and Slaney 1996). The level 1 FHAP is a purposive field survey of current habitat conditions for the target species in select reaches. This form has been developed for interpretation of habitat sensitivity and capability for fish production and includes prominent physical features such as pool and riffle ratios, residual pool depths, channel stability, flood indicators, cover components, abundance of large woody debris (LWD), and riparian vegetation.

Following methods described in Rosgen (1996) the following measurement of channel profile, pattern and dimension were also completed:

- A longitudinal profile (minimum of 20 channel widths in length or a distance equal to two stream meander wavelengths) of the stream bed following the thalweg of the stream channel including measurement of water surface (slope) and bankfull elevations;
- Stream cross-sections on both a riffle and pool segment (stream bed, thalweg and bankfull elevations);

- Channel pattern (width flood prone area, sinuosity, belt width, meander length and radius of curvature), and
- Modified Wolman pebble count (reach and active channel at a riffle).

At 10 m intervals, following the thalweg of the stream channel, the elevation of the streambed and the water surface was surveyed over the length of the study area. All stream and habitat unit gradients were calculated from differences in water surface elevation. Cross sectional profiles were surveyed at 1 m intervals and extended 5 to 10 m beyond the bankfull width. The elevation of the bankfull channel was also noted at each cross section location and periodically throughout the longitudinal survey. Geomorphic surveys were completed using an auto level (Topcon AT-G7 Auto Level) and standard differential hydrometric survey techniques (Anon. 1998). A differential loop was used to accurately determine benchmark elevations, express error terms and ensure quality control.

Channel bed material characterization employed the modified Wolman method outlined in Rosgen (1996). Briefly, this procedure uses a stratified, systematic sampling method based on the frequency of riffle/pools and step/pools occurring within a channel reach that is approximately 20-30 bankfull channel widths in length (or two meander wavelengths). The modified method adjusts the material sampling locations so that various bed features are sampled on a proportional basis along a given stream reach. In total, 10 transects are established and ten substrate particles are selected at systematic intervals across the bankfull channel width, for a total sample size of 100. To avoid potential bias, the actual particle was selected on the first blind touch, rather than visually selected. The intermediate axis of the particle was measured such that the particle size selected would be retained or pass a standard sieve of fixed opening. The composite particle distribution was used to represent the reach. A second modified Wolman pebble count was completed within the active channel (*i.e*. within the wetted width), at the representative riffle cross-section, to calculate D_{84}. The D_{84} estimate was then used as a roughness coefficient in velocity calculations (Appendix G).

3 Results

The sampling schedule for the Skookumchuck Creek fish and fish habitat-monitoring program is summarized in Table 1.

Table 1. Schedule of program field components for the Skookumchuck Creek bull trout and fish habitat monitoring program, 2002 to 2003.

Program Component	2002	2003
Establishment Sample Sites and Site Reviews	July 24	July 24-25
Juvenile Fish Density Sampling	August 12-15	August 4-7
Level 1 FHAP Form 4 Measurements and Channel Surveys	September 22 – October 1	July 31-August 3 and August 12-September 26

3.1 Juvenile Fish Sampling

3.1.1 Species Composition and Distribution

In total, 13 habitat units were sampled across four sites (Appendix B). Table 2 summarizes the 2003 sample effort and total catch across sites. Note that site 4 represents the Sandown Creek site added in 2003.

Table 2. Total effort (seconds of backpack electrofishing and area) and catch (no. of fry and juvenile bull trout and Westslope cutthroat trout combined) for the four Skookumchuck Creek bull trout index sites. Note that the totals denoted by brackets include the catch of non-target species.

Site	Electrofishing Effort (seconds)	Sample Area (m^2)	Total Catch (No. Fish)
1	9,025	454.0	9(70)
2	9,019	452.4	60
3	8,779	464.7	84
4	8,762	498.3	34
Total	35,585	1,869.4	187(248)

Table 3 provides a comparative illustration of sample effort and total catch across the first two years of study. Although sample effort was consistent across the three index sites sampled in both years, the bull trout and Westslope cutthroat trout fry and juvenile catch within sites 1 through 3 was 77.9% higher in 2003.

Table 3. Total effort (seconds of backpack electrofishing and area) and catch (no. of fry and juvenile bull trout and Westslope cutthroat trout combined) for the 2002 and 2003 sample programs. Note that the totals denoted by brackets include the catch of non-target species.

Year	Electrofishing Effort (seconds)	Sample Area (m^2)	Total Catch (No. Fish)
2002	25,916	1,419.0	86(116)
2003	26,823	1,371.1	153(214)
2003[a]	35,585	1,869.4	187(248)

a – Note that these totals include the fourth index site located in Sandown Creek that was added in 2003.

In total, 248 fish were captured within the Skookumchuck Creek index sites (Table 4). A total of 187 juvenile bull trout (BT) and Westslope cutthroat trout (WCT) representing 75.4% of the catch were captured during the sample period 4 – 7 August 2003. Bull trout (n = 123) and Westslope cutthroat trout (n = 64) were the dominant salmonid species encountered, representing 49.6% and 25.8% of the total catch, respectively. Bull trout fry were the target species and life stage and as such, their predominance in the catch composition reflects bias associated with site selection for this capture target. Mountain whitefish fry were captured exclusively within the lower watershed index site. This species was not captured in 2002. Additional non-salmonid catch was represented by longnose suckers (LSU) and torrent sculpins (CRH) that were captured exclusively within the lower watershed index site (Table 4).

Table 4. Catch composition for the Skookumchuck Creek juvenile bull trout monitoring program, August 4-7, 2003.

Site	BT Fry	BT Juv.	WCT Fry	Wct Juv.	MW Fry	LSU	CRH	Total
1	6	1		2	8	41	12	70
2	44	2	13	1				60
3	58	1	21	4				84
4	6	5		23				34
Totals	114	9	34	30	8	41	12	248

Inter-annual comparisons (Table 5) illustrate several notable increases in catch for 2003. There was a notable increase in bull trout fry and Westslope cutthroat trout fry captures. The increased fry captures were predominantly from sites 2 and 3 located in the upper watershed within the known spawning habitat (Table 4). Mountain whitefish spawning and rearing within Skookumchuck Creek has been documented and the absence of fry in 2002 was unexpected. Finally, the addition of the Sandown Creek site demonstrates the importance of this stream to rearing juveniles, particularly Westslope cutthroat trout.

Table 5. Catch composition for the Skookumchuck Creek juvenile bull trout monitoring program, 2002 - 2003.

Year	BT Fry	BT Juv.	WCT Fry	Wct Juv.	MW Fry	LSU	CRH	Total
2002	79	5	1	1	0	15	15	116
2003	108	4	35	6	8	41	12	214
2003[a]	114	9	35	29	8	41	12	248

a – Note that these totals include the fourth index site located in Sandown Creek that was added in 2003.

In total, 229 fish were observed during snorkel surveys within the Skookumchuck Creek index sites (Table 6). Snorkel length was approximately 1,000 m for each site. Site 1 was snorkeled on July 18 and Sites 2 and 3 were snorkeled on July 29 and 30, respectively. A total of 15 adult bull trout greater than 500 mm were observed. These fish were present within all three index sites and represent pre-spawners holding within Skookumchuck Creek prior to spawning in September. A total of 149 sub-adult and adult Westslope cutthroat trout were observed. Westslope cutthroat trout were the dominant species for the adult/sub-adult life stage and were observed in abundance across all three index sites. Mountain whitefish fry, juveniles and adults/sub-adults were observed within all index sites but were far more abundant within the lower Skookumchuck index site.

Table 6. Snorkel survey results for the mainstem Skookumchuck Creek index sites, July 18, 29 and 30, 2003. Note that with the exception of one observation all bull trout and Westslope cutthroat trout observations represent fish > 200 mm fork length.

Site	WCT	BT	MW	Total
1	31	7	56	94
2	86	3	4	93
3	32	5	5	42
Total	149	15	65	229

3.1.2 Bull Trout

Bull trout fry (n=114) and juveniles (n=9) were captured in all sample sites, including Sandown Creek (Table 4). In total, 123 bull trout were captured and sampled for life history information (Table 7). All captured bull trout were fry or juveniles and ranged in fork length from 35 mm to 171 mm and the modal class, in 10 mm intervals, was 40-49 mm (Figure 4). This size class represents the young-of-the-year cohort (fry, 0^+). The relative proportions of age classes comprising the total bull trout catch were 92.7% fry (0^+) and 7.3% juveniles (1^+ and 2^+). Mean fork lengths of each age class (estimate) were 47.7 (0^+), 108.2 (1^+) and one two-year old fish measuring 171 mm was captured. The corresponding mean weights for bull trout age classes were 1.24 g, 10.7 g and 47.5 g, respectively (Table 7). The growth rate of juvenile bull trout in the Skookumchuck Creek study area was described by the equation:

$$\mathrm{Log}_{10}\mathrm{Weight} = -4.77 + 2.89\ \mathrm{Log}_{10}\mathrm{Length}$$ (Figure 5).

Skookumchuck Creek bull trout catch composition and life history parameters were consistent across sample years. The one notable exception was that 2003 fry captures were significantly larger than 2002 fry captures (44.6 mm versus 47.7 mm; t-Test, $P < 0.5$).

Table 7. Summary of fork length and weight data collected from bull trout captured within the Skookumchuck Creek drainage, August 2003.

	Age-Group		
	0^+	1^+	2^+
Mean Fork Length	47.7	108.2	171
Standard Error	0.42	8.54	
Range	35-63	82-114	
N	114	8	1
Mean Weight (g)	1.24	10.7	47.5
Standard Error	0.04	1.05	
Range	0.5-2.5	5.2-14.2	
N	114	8	1

The overall mean density of fry and juvenile bull trout (ages 0^+, 1^+ and 2^+ combined) for the 2003 sampling program (n=4 sites) was estimated to be 7.27 fish/100 m^2 (95% confidence interval 6.58 – 8.01 fish/100 m^2; Table 8). The mean bull trout fry density was 6.85 fish/100 m^2 (95% confidence interval 6.10 – 7.65 fish/100 m^2) and the mean bull trout juvenile density was 0.48 fish/100 m^2 (95% confidence interval 0.48 – 0.51 fish/100 m^2). Although

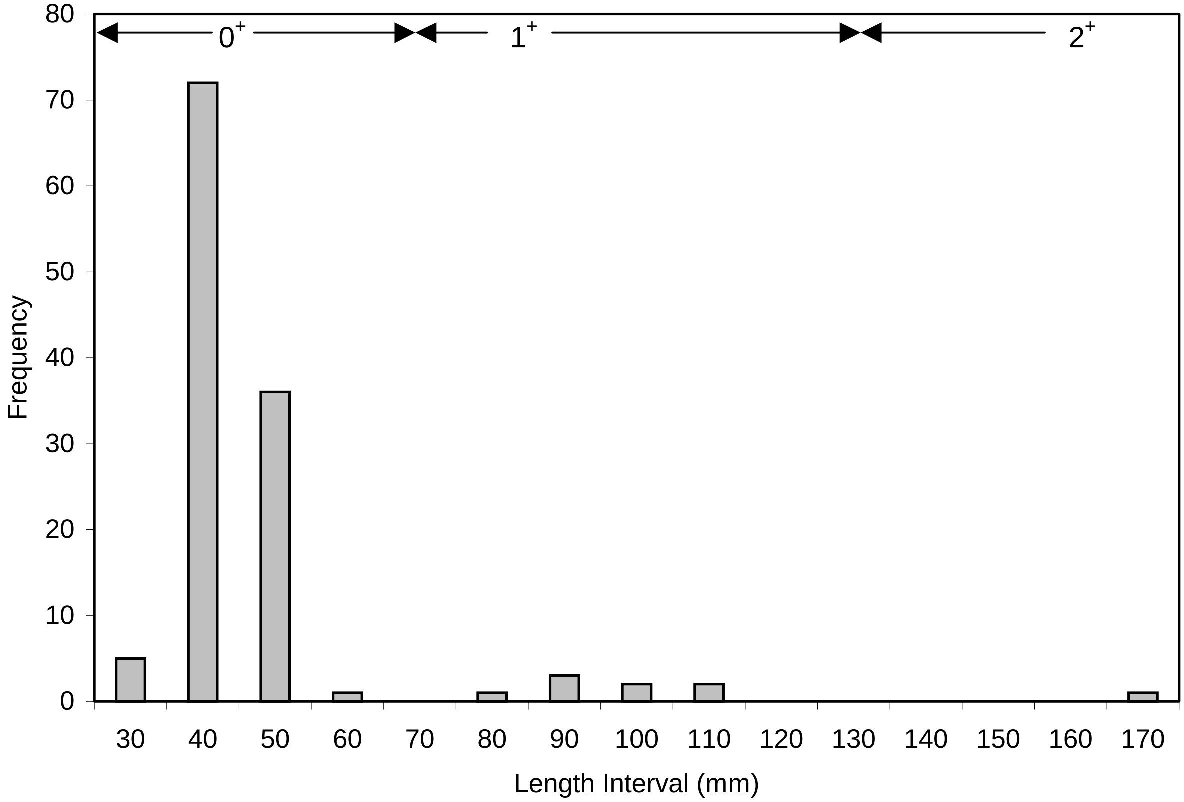

Figure 4. Length frequency distribution and estimated age cohorts for Skookumchuck Creek fry and juvenile bull trout, August 2003.

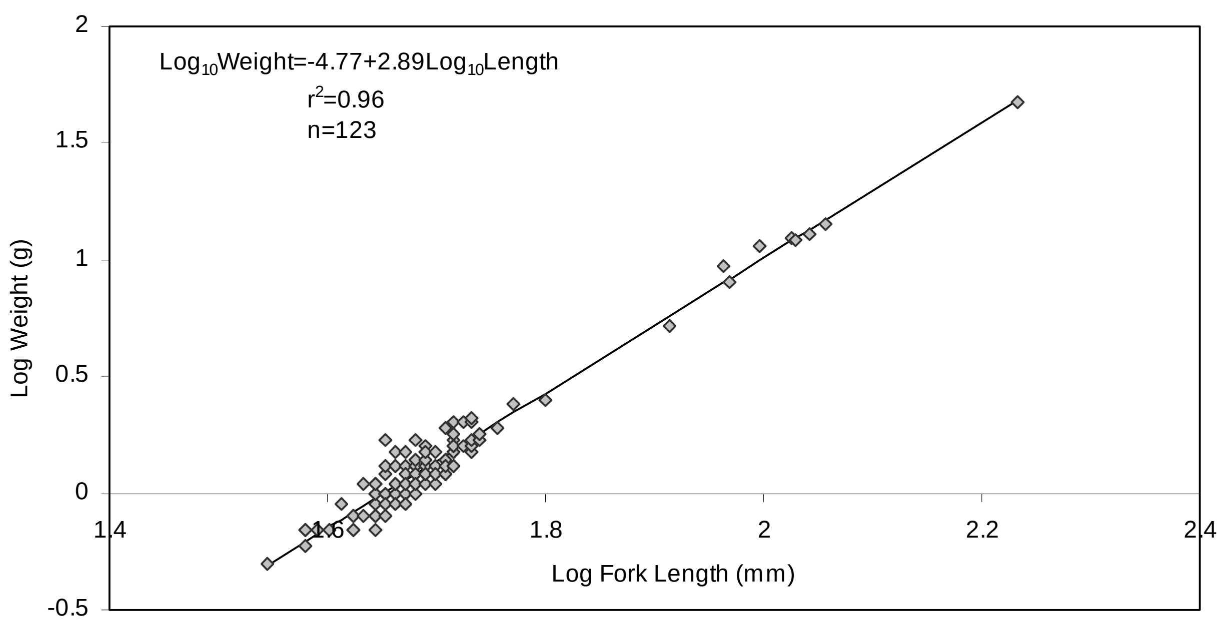

Figure 5. Length-weight regression for bull trout captured within the Skookumchuck Creek watershed, August 2003.

Table 8. Mean density estimates (+/- 95% confidence interval) for juvenile bull trout (fry and juveniles combined) at four permanent sample sites within the Skookumchuck Creek watershed, 2002 - 2003.

Site	Density (+/- 95% C.I.) fish/100 m^2 2002	2003
Skookumchuck Creek – Site 1	0.8 (0.8 – 1.7)	1.5 (1.5 – 1.7)
Skookumchuck Creek – Site 2	9.7 (9.3 – 10.9)	10.4 (10.2 – 11.2)
Skookumchuck Creek – Site 3	8.8 (8.2 – 10.3)	16.4 (12.7 – 21.7)
Sandown Creek – Site 4	N/a	2.2 (2.2 – 2.5)
Mean	6.6 (5.9 – 7.3)	7.3 (6.6 – 8.0) [a] 9.1 (8.2 – 10.2)

a – Note that this total includes the fourth index site located in Sandown Creek that was added in 2003.

this was not significantly higher than the 2002 sample program, this was due to the low density of bull trout within the Sandown Creek site that was added in 2003. Comparison of the mean annual bull trout fry and juvenile densities between the three Skookumchuck Creek sites sampled in both 2002 and 2003 illustrates that the density of bull trout fry and juveniles within these sample sites was significantly higher in 2003 than in 2002 (Table 8).

The mean density of fry and juvenile bull trout within individual index sites ranged from 1.5 to 16.4 fish/100 m^2 (Table 7). Although mean densities in 2003 were higher for all sites also sampled in 2002, the majority of the variation was related to the significant increase in densities at the upper site (Site 3; Table 8). Densities were significantly lower in the lower Skookumchuck and Sandown Creek sites than the upper Skookumchuck Creek sites and these differences were principally related to proximity to spawning areas.

Based on the snorkel count in July, the adult bull trout densities were generally low, ranging from 0.3 to 0.7 fish/100 lineal m. These fish represent pre-spawners that would have just begun entering Skookumchuck Creek in preparation for spawning in September.

3.1.3 Westslope Cutthroat Trout

Westslope cutthroat trout fry (n=34) were captured exclusively in sites 2 and 3 (the preferred bull trout spawning reaches). The capture of cutthroat trout fry in 2003 but not in 2002 was thought to represent an earlier date of emergence due to warmer water temperatures in 2003. Juveniles (n=30) were captured in all sample sites, however

Sandown Creek captures represented 76.7% of all juvenile captures and was clearly preferred habitat for cutthroat trout juveniles (Table 4). In total, 64 Westslope cutthroat trout were captured and sampled for life history information (Table 9). All captured cutthroat trout were fry, juveniles or sub-adults and ranged in fork length from 21 mm to 235 mm and the modal class, in 10 mm intervals, was 20-29 mm (Figure 6). This size class represents the young-of-the-year cohort (fry, 0^+). The relative proportions of age classes comprising the total cutthroat trout catch were 53.1% fry (0^+), 42.2% juveniles (1^+ and 2^+) and 4.7% sub-adults (3^+). Mean fork lengths of each age class (estimate) were 28.2 mm (0^+), 73.1 mm (1^+), 133.8 mm (2^+) and 216.7 mm (3^+). The corresponding mean weights for these age classes were 0.2 g, 4.5 g, 27.9 g and 123.7g, respectively (Table 9).

Table 9. Summary of fork length and weight data collected from Westslope cutthroat trout captured within the Skookumchuck Creek drainage, August 2003.

	Age-Group			
	0^+	1^+	2^+	3^+
Mean Fork Length	28.2	73.1	133.8	216.7
Standard Error	0.69	2.09	12.14	9.28
Range	21-37	52-93	110-165	205-235
N	34	23	4	3
Mean Weight (g)	0.2	4.5	27.9	123.7
Standard Error	0.02	0.37	8.36	10.36
Range	0.1-0.6	1.5-8.6	14.1-51.9	111.0-144.2
N	34	23	4	3

The growth rate of Westslope cutthroat trout captures (2003) in the Skookumchuck Creek study area was described by the equation:

$$\text{Log}_{10}\text{Weight} = -5.28 + 3.16\ \text{Log}_{10}\text{Length (Figure 7).}$$

The overall mean density of fry, juvenile and sub-adult Westslope cutthroat trout (ages 0^+ through 3^+ combined) for the 2003 sampling program (n=4 sites) was estimated to be 3.74 fish/100 m^2 (95% confidence interval 3.42 – 4.23 fish/100 m^2; Table 10). The mean cutthroat trout fry density was 2.46 fish/100 m^2 (95% confidence interval 1.82 – 3.75 fish/100 m^2) and the mean juvenile and sub-adult density was 1.60 fish/100 m^2 (95% confidence interval 1.60 – 1.67 fish/100 m^2). Comparison of the mean annual fry and juvenile densities between the four Skookumchuck Creek sites sampled in 2003 (Table 10), illustrates that the density of cutthroat trout fry was significantly higher in sites 2 and 3 (densities represent predominantly fry) and the density of cutthroat trout juveniles was

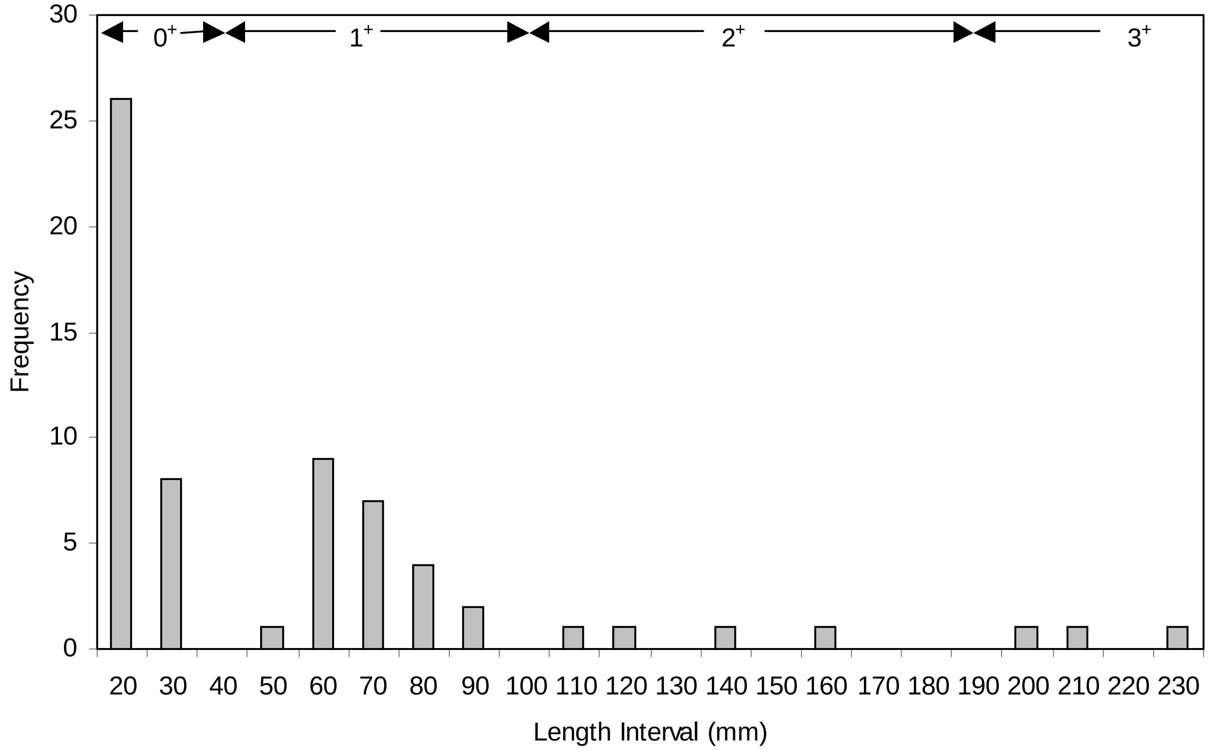

Figure 6. Length frequency distribution and estimated age cohorts for Skookumchuck Creek fry and juvenile Westslope cutthroat trout, August 2003.

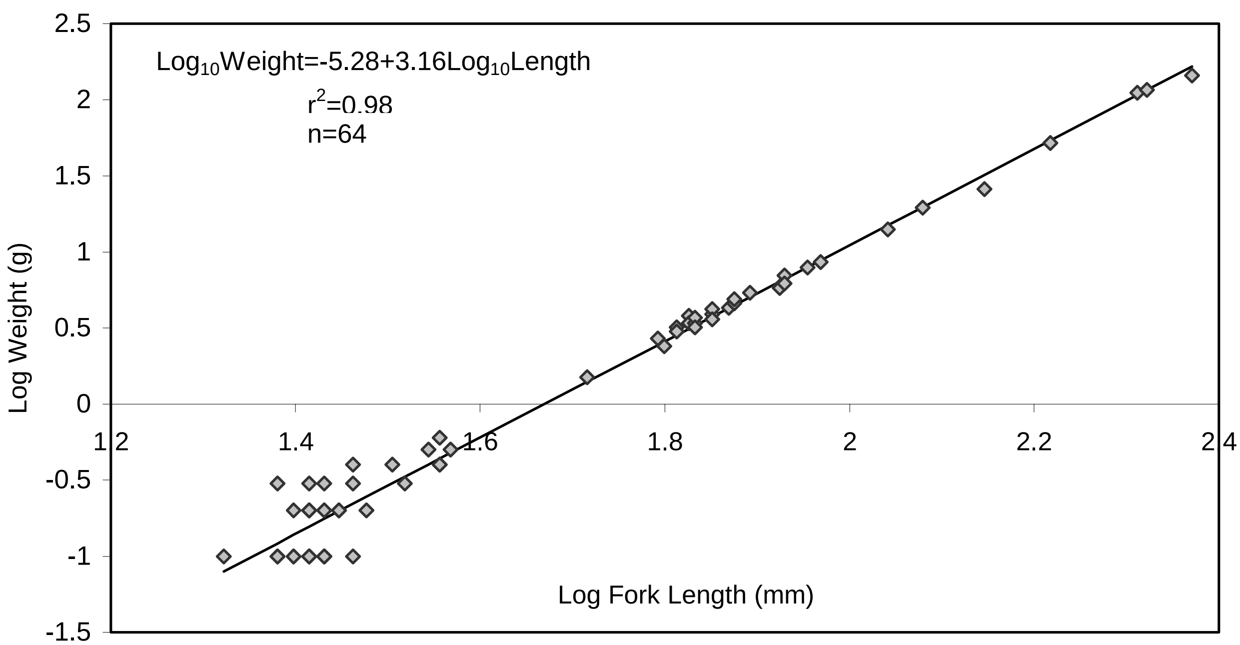

Figure 7. Length-weight regression for Westslope cutthroat trout captured within the Skookumchuck Creek watershed, August 2003.

Table 10. Mean density estimates (+/- 95% confidence interval) for juvenile Westslope cutthroat trout (fry and juveniles combined) at four permanent sample sites within the Skookumchuck Creek watershed, 2003.

Site	Density (+/- 95% C.I.) fish/100 m^2 2002[a]	2003
Skookumchuck Creek – Site 1	N/a	N/a[1]
Skookumchuck Creek – Site 2	N/a	5.53(3.09-15.19)
Skookumchuck Creek – Site 3	N/a	5.38(5.16-6.29)
Sandown Creek – Site 4	N/a	4.62(4.62-4.94)
Mean	N/a	3.74(3.42-4.23)

a – Note that in 2002 the small sample size (n=2) precluded analyses.
1 - Note that in 2003 the small sample size (n=2) precluded analyses.

significantly higher in Sandown Creek (density of site 4 exclusively juveniles/sub-adults). Lower watershed habitat would appear to support significantly lower densities of fry and juveniles.

Based on the snorkel counts, the sub-adult and adult Westslope cutthroat trout densities were 3.1 and 3.2 fish/100 lineal m for sites 1 and 3, respectively, while site 2 densities were 8.6 fish/100 lineal m. The high densities of adult cutthroat trout within site 2 were attributed to habitat quality and in particular the abundance of deep pool habitat (*see* 3.1.3 Channel Surveys).

3.2 Physical Habitat Monitoring

3.2.1 Water Temperature and Discharge

Discharge estimates within the Skookumchuck Creek index sites, during fish sampling, ranged from 5.21 to 0.18 m^3/s and were between 30% and 16.4% lower than 2002 fish sampling discharges (Table 11). The 2003 (9 April to 3 November) minimum and maximum daily discharge at the lower Skookumchuck Creek hydrometric station ranged from 2.46 to 69.2 m^3/s and the 2003 freshet was much reduced in duration and magnitude from the 2002 sample period (Figure 8). The 2003 maximum instantaneous discharge for Skookumchuck Creek was 87.9 m^3/s (June 9, 2003). The maximum instantaneous and maximum daily discharges were 29.7% and 34.1% lower than 2002 (Table 11). Spot temperatures during electrofishing were within bull trout tolerance limits (<18 ^{o}C) and in general, were indicative of cold perennial springs preferred by bull trout (<12 ^{o}C). .

Table 11. Summary of water temperature, mean velocity, and discharge measurements for the Skookumchuck Creek monitoring sites, 2002 to 2003.

Site	Date	Discharge (m^3/s)	Mean Velocity (m/s)	Water Temp. (^oC)	Max. Inst. Discharge[1] (m^3/s)	Max. Daily Discharge[1] (m^3/s)
Site 1	12 Aug., 2002	7.52	0.59	11.3	125	105
	4 Aug., 2003	5.21	0.40	16.8	87.9	69.2
Site 2	14 Aug., 2002	5.73	0.40	11.8		
	6 Aug., 2003	4.79	0.57	12.8		
Site 3	15 Aug., 2002	5.05	0.39	10.9		
	7 Aug., 2003	4.16	0.37	11.0		
Site 4[a]	5 Aug., 2003	0.18	0.34	11.0		

1 - Note that this data was from Nanrich Water Management Consultants Ltd. hydrometric station maintained at the upstream end of this site.

a - Note that the fourth index site was located in Sandown Creek and was added in 2003.

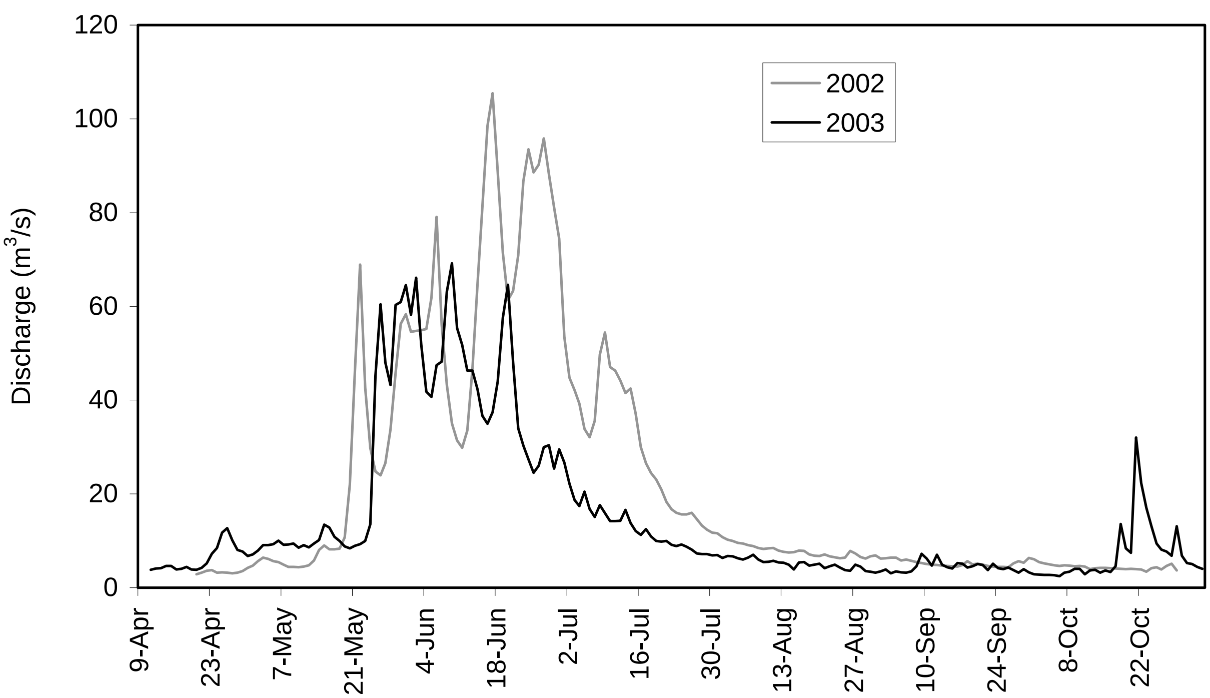

Figure 8. Mean daily discharge for the Skookumchuck Creek hydrometric station located at approximate river kilometer 2 (Site 1), (Nanrich Water Management Consultants Ltd., File Data).

Bankfull discharge was estimated from flood frequency analysis conducted using maximum daily discharges recorded at the historical Water Survey of Canada Hydrometric Station (08NG051; 1949-55; 1963-84; n=26) and the Nanrich Water Management Consultants Ltd. hydrometric station (2000-03; n=4; Figure 9). Both hydrometric stations were located very near each other within Site 1. Estimated bankfull discharge was 69.5 m^3/s based on a return frequency of 1.5 years. Table 12 illustrates the bounds of the expected bankfull discharge (*i.e*. between 1 and 2 year flood frequency) for sample sites one through four. The bankfull discharge estimates for the study area above the WSC gauge were transferred using the following equation:

Site Discharge = WSC Gauge Discharge * (Area above Site/Area above Gauge)$^{0.75}$

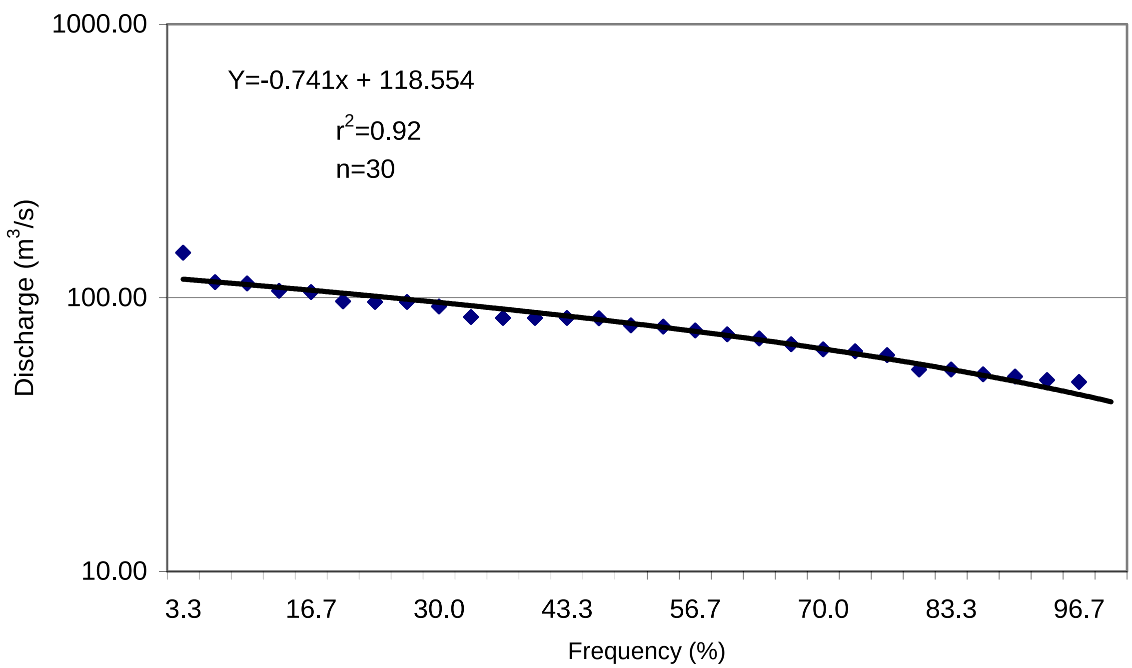

Figure 9. Flood-frequency analysis using maximum daily discharge for Skookumchuck Creek Water Survey of Canada Station 08NG051 (1949-55; 1963-84) and Nanrich Water Management Consultants Ltd. (2000-03).

Table 12. Discharge estimates for the range of potential bankfull discharges based on the historical maximum daily discharge records of Skookumchuck Creek (1949-55; 1963-84; 2000-03).

	Discharge Estimate (m^3/s)			
Flood-Frequency	Site 1	Site 2	Site 3	Site 4[a]
1:2	81.9	62.0	59.5	13.0
1:1.5	69.5	52.6	50.5	11.0
1:1	44.6	33.8	32.5	7.1

a – Note that there was no historical discharge data for Sandown Creek and discharge estimates are based on Skookumchuck Creek data and the ratio of watershed area.

3.1.2 Substrate Pebble Counts

Mean size of sediment particles less than six percent categories (*i.e.* D_{16}, D_{35}, D_{50}, D_{65}, D_{84}, D_{95}) are provided for the 2003 pebble counts. Both the active channel in a riffle and the reach composite within the bankfull channel are presented for the four index sites (Table 13). Results were consistent with 2002 samples. For example, the maximum variation in D_{84} between 2002 and 2003 samples was 10.4%. The preferred spawning reach (Site 3) was dominated by small to large cobbles with gravel substrate sub-dominant (Appendix D).

Table 13. Summary of substrate pebble counts for the Skookumchuck Creek fish habitat monitoring sites, 2003.

Site	D^{16}(mm)	D^{35}(mm)	D^{50}(mm)	D^{65}(mm)	D^{84}(mm)	D^{95}(mm)
Skookumchuck Creek Site 1 (Reach)	32.0	81.0	106.7	139	223	384
Skookumchuck Creek Site 1 (Active Channel)	49.8	104.4	135.5	168	233	388
Skookumchuck Creek Site 2 (Reach)	32.0	66.0	105.6	147	215	318
Skookumchuck Creek Site 2 (Active Channel)	96.6	133.8	167.1	202	253	362
Skookumchuck Creek Site 3 (Reach)	6.9	58.6	93.6	126	215	362
Skookumchuck Creek Site 3 (Active Channel)	83.7	119.3	151.8	191	252	512
Sandown Creek Site 4 (Reach)	1.3	6.4	15.6	23	42	74
Sandown Creek Site 4 (Active Channel)	7.1	17.5	25.9	35	45	62

3.1.3 Channel Surveys

Channel longitudinal and cross sectional profiles were completed for each of the sample stations and were presented in Appendix D. Detailed quantitative summaries are presented in the Stream Classification Form (Appendix E), the Reference Reach Data Summary Form (Appendix F) and the Velocity Calculation Form (Appendix G). The following summarizes the general channel features noted with associated representative riffle and pool photographs.

Skookumchuck Creek Site 1

In 2003, two modifications were implemented to Site 1 based on the data analyses compiled during the initial sample program. First, Site 1 was extended by 210 m to encompass the entire two meander lengths rather than just meet the minimum length of 20 channel widths. This did not alter the channel classification from the previous year as the inclusion of a further 210 m only resulted in minor changes to the summary data. Secondly, based on field observations during spring freshet and hydraulic analyses conducted in 2002, the bankfull height was lowered slightly. This resulted in a better fit among index sites between observed bankfull indicators, bankfull cross-sectional area, estimated bankfull discharge and estimated water velocity.

Site 1 was classified as a C3(1) Rosgen stream type (Figures 10 and 11). The (1) designation refers to the presence of bedrock outcrops that were associated with pools. This site was adjacent to the Skookumchuck Pulp mill and riparian development, eroding banks and channel alterations were noted. The channel slope was 0.58% and bankfull width was 31.1 m within a flood-prone width of 121 m. This site was representative of the lower Skookumchuck Creek watershed where it exits the Skookumchuck Canyon and flows through the Kootenay River terrace. Site 1 represented the lower Skookumchuck outside the “preferred” bull trout spawning reaches and had a higher gradient with lower pool frequency, lower LWD frequency and a smaller gravel fraction within the streambed.

Figure 10. Representative riffle habitat, Site 1, Skookumchuck Creek, 2002 and 2003.

Figure 11. Representative pool habitat, Site 1, Skookumchuck Creek, 2002 and 2003.

Skookumchuck Creek Site 2

In 2003, two modifications were implemented to Site 2 based on the results of the first year. First, the riffle cross-section was adjusted from the bottom of the riffle to the top of the same riffle. This was done to eliminate potential width bias from backwatering due to the large pool immediately downstream. This change resulted in a narrower bankfull channel width, however the flood prone width and channel classification remained unchanged from the previous year. Secondly, based on field observations during spring freshet and hydraulic analyses conducted in 2002, the bankfull height was lowered slightly. This resulted in a better fit among index sites between observed bankfull indicators, bankfull cross-sectional area, estimated bankfull discharge and estimated water velocity.

Site 2 was classified as a C3 Rosgen stream type (Figures 12 and 13). This site was noted for its frequent deep pools, off-channel habitat, groundwater infiltration, and stable stream banks. The channel slope was 0.36% and bankfull width was 33.0 m within a flood-prone width of 123 m.

This site was representative of low-density bull trout spawning habitat and high-density adult Westslope cutthroat trout rearing habitat within the upper Skookumchuck. Site 2 was noted for its habitat heterogeneity and of the three mainstem index sites, had the highest channel sinuosity, lowest gradient, highest pool frequency, LWD frequency and highest sub-dominant fraction of gravels within the streambed (Appendix D). LWD frequency was most likely under-represented due to the clumped distribution of LWD and the low sample frequency (*i.e*. two meander lengths).

Figure 12. Representative riffle habitat, Site 2, Skookumchuck Creek, 2003.

Figure 13. Representative pool habitat, Site 2, Skookumchuck Creek, 2002 and 2003.

Skookumchuck Creek Site 3

In 2003, three modifications were made to Site 3 based on the results of the initial sample program. First, Site 3 was extended by 100 m to include the long pool tail-out and encompass the entire two meander lengths rather than just meet the minimum length of 20 channel widths. This did not alter the channel classification from the previous year as the inclusion of a further 100 m only resulted in minor changes to the summary data.

Secondly, based on field observations during spring freshet and hydraulic analyses conducted in 2002, the bankfull height was lowered slightly. This resulted in a better fit among index sites between observed bankfull indicators, bankfull cross-sectional area, estimated bankfull discharge and estimated water velocity.

Finally, in 2002, site 3 was classified as a B3c Rosgen stream type (Figures 14 and 15). The c designation refers to the low gradient “C” channel characteristics of this sub-variant B channel. The B3c classification appeared to be the result of entrenchment increasing to just beyond the C3 range within the upstream meander, where the representative riffle cross-section was located. In 2003, replication of the riffle cross-section in the downstream meander resulted in an increase of the entrenchment ratio from 1.73 to 2.26, resulting in a C3 stream classification (Figure 16). Therefore, the two meander lengths selected for survey encompassed the reach break between the B3 and C3 channel types as the reach approaches the falls 2.5 kilometers upstream.

This site was representative of the preferred bull trout spawning habitat immediately below the falls at km 45. Of the three index sites, site 3 was noted as being intermediate in its habitat heterogeneity. Channel sinuosity, gradient and pool frequency were similar to site 2 but slightly reduced, while entrenchment ratio was the lowest of the three sites. This site was noted for its frequent pools, higher proportion of spawning substrate, groundwater infiltration, and stable stream banks. The channel slope was 0.36% and bankfull width was 32.5 m within a flood-prone width of 67 m.

Figure 14. Representative riffle habitat within the upstream meander of Site 3, Skookumchuck Creek, 2002.

Figure 15. Representative pool habitat, Site 3, Skookumchuck Creek, 2002 and 2003.

Figure 16. Representative riffle habitat within the downstream meander, Site 3, Skookumchuck Creek, 2003.

Skookumchuck Creek Site 4

In 2003, Site 4 was added to represent tributary rearing habitat within the upper Skookumchuck watershed, and to collect baseline information on this important tributary that also supports a major proportion of the current forest harvesting activity.

Sandown Creek represents a much smaller watershed and site 4 was classified as undergoing a successional evolution from an F4 stream type to a C4 stream type (Figures 17 and 18). Historic wildfire and forest harvesting activity has resulted in extensive channel impacts and sediment movement. Large, elevated bedload deposits in the form of sediment wedges were noted along with subsequent channel entrenchment within these bedload deposits. Riparian vegetation was dominated by willow and shrubs. The channel slope was 0.64% and bankfull width was 9.6 m within a flood-prone width of 23 m. Site 4 represented “preferred” juvenile summer rearing habitat and had high densities of juvenile and sub-adult Westslope cutthroat trout. This site was characterized by much shallower water depths that were inappropriate for adult bull trout and high LWD frequency that contributed to the observed high habitat complexity.

Figure 17. Representative riffle habitat, Site 4, Sandown Creek, 2003.

Figure 18. Representative pool habitat, Site 4, Sandown Creek, 2003.

3.2.3 Fish Habitat Survey (FHAP Form 4)

The Level 1 Fish Habitat Assessment Procedure (FHAP) is a purposive field survey of current habitat conditions for the target species in select reaches. In this study, the Level 1 FHAP Form 4 was completed for the representative sample sites (two meander wavelengths) within the selected reaches. The output of the WRP data reporting tool are presented in Appendix C and have been archived for long-term trend monitoring. Generic diagnostic data have been summarized as descriptors of present habitat condition (Tables 14 and 15). Cover components utilized by fry and juvenile bull trout and cutthroat trout were typically shallow water depths, substrate interstices, boulder, and LWD. Sub-adult and adult bull trout and Westslope cutthroat trout typically utilized water depth (*i.e*. >0.8 m), LWD, boulders, cutbanks and overhead vegetation for cover.

Note that regional criteria for habitat conditions do not exist and current WRP diagnostic criteria to evaluate habitat condition are exclusive of bull trout and Westslope cutthroat trout data. Notwithstanding these limitations, diagnostic data clearly indicate the high quality spawning and rearing habitat ratings for sites 2, 3 and 4. Bankfull channel widths were derived from the riffle habitat unit cross-sectional survey data. Gradient was derived from the water surface elevation of the longitudinal profile. LWD distribution was clumped and was under-represented by low sampling frequency (*i.e*. 2 meander lengths).

Comparisons of key annual habitat diagnostics data (2002-2003) for the index sites within Skookumchuck Creek are provided for trend monitoring and to illustrate inter-annual variability (Table 15). In 2003, the observed changes in habitat diagnostics were primarily due to site modifications that were implemented based on experience that was gained in the first year of study. The bankfull height was lowered and this resulted in a corresponding decrease in bankfull width. Extension of the index sites at Site 1 and 3 resulted in the increased pool area and increases to total LWD counts. The decrease in pool area for site 2 was due to a better job of separating the run habitat and glide habitat from pool habitat.

Table 14. Diagnostics of salmonid habitat condition at the reach level for Skookumchuck Creek, 2003 (from Johnston and Slaney 1996). Note that the individual cell format represents value/rating[a, b].

	Habitat Parameter											
	Pool % (by area)	Pool Frequency (mean spacing)	LWD Pieces per Bankfull Channel Width	% Wood Cover in Pools	% Boulder Cover in Riffles	% Over-head Cover	Substrate Rearing Habitat (interstitial rating)	Off-Channel Habitat (< 3% gradient)	Holding Pools (> 1 m deep, good cover)	Spawning Gravel Quantity	Spawning Gravel Quality	Redd Scour Potential
Site 1 Skookumchuck Creek	28.0 / P	5.23 / P	1.54 / F	0 / P	9 / P	<2 / P	Clear / G	Few / P	Few / P	Limited / P	Suitable / G	High / P
Site 2 Skookumchuck Creek	41.4 / F	2.78 / F	0.80 / P	<2 / P	9 / P	<2 / P	Clear / G	Abundant / G	Abundant / G	Frequent / G	Suitable / G	Stable / G
Site 3 Skookumchuck Creek.	42.3 / F	3.19 / F	1.80 / F	3 / P	<2 / P	7 / P	Clear / G	Some / F	Abundant / G	Frequent / G	Suitable / G	Stable / G
Site 4 Sandown Creek	33.0 / P	2.27 / F	3.62 / G	24 / G	4 / P	12 / F	Reduced / F	Few / P	Few / P	Frequent / G	Suitable / G	Some / F

a Note: regional standards are not available and diagnostic ratings (G – good, F – fair, P – poor) are generalized ratings from Johnston and Slaney (1996) for streams with a bankfull channel width of less than 15 m.
b Note: two representative meander lengths were surveyed, not the entire reach.

Table 15. Inter-annual comparison of select habitat condition diagnostics for permanent index sites (from Johnston and Slaney 1996). Note that qualitative ratings for rearing and spawning habitat (see Table 14) were invariable across samples years and are not presented here for brevity.

Site	Year	Mean Gradient (%)	Mean Bankfull Channel Width (m)	Mean Max. Bankfull Depth (m)	Mean Water Depth (m)	No. Pools Within Sample Reach	% Pool Habitat (area)	Pool Freq. (pool Spacing $/W_b$)	Total Func. LWD Tally	LWD Pieces/ Bankfull Channel Width	% Wood Cover in Pools	% Boulder Cover in Riffles	% Overhead Cover	D84
1[a,c]	2002	0.65	34.3	1.26	0.66	2	18	7.2	33	1.4	0	7	<2	99
	2003	0.58	31.1	1.20	0.78	4	28	5.2	51	1.5	0	9	<2	107
2[a,b]	2002	0.35	41.2	1.32	0.81	6	52	1.5	20	0.9	<2	11	<2	90
	2003	0.36	33.0	1.20	0.84	6	41	2.8	23	0.8	<2	9	<2	106
3[a,c]	2002	0.38	32.8	1.10	0.64	5	38	3.0	41	1.6	<2	<2	10	80
	2003	0.36	32.5	1.15	0.68	4	42	3.2	51	1.8	3	<2	7	94
4	2003	0.64	9.6	0.58	0.30	7	33	2.3	81	3.6	24	4	12	16

a – bankfull height was lowered slightly based on the first years results. This resulted in a decrease in bankfull channel width.

b –the representative cross-section was moved in 2003 and this resulted in a significant change to bankfull channel width and maximum bankfull depth.

c – the index site was extended in 2003 to include two full meander lengths. This resulted in minor changes to channel gradient, % pool habitat, pool spacing, and total LWD tally.

4 Discussion

The 2003 project year represents the second year of a long-term bull trout-monitoring program with current studies focused on collecting baseline information and “fine-tuning” habitat diagnostics data based on experience gained from the first year. Sandown Creek is an important Westslope cutthroat trout and bull trout rearing and spawning stream in the upper Skookumchuck. Scheduled harvesting within this tributary watershed totaled 324.9 ha or 43.8% of the allowable harvest area for the current 5-year Skookumchuck watershed FDP. A fourth index site representing this tributary was established in lower Sandown Creek and included for baseline data collection in year two.

Relative to co-existing species, bull trout densities usually are low, and most broad faunal surveys indicate less than 5% of the total catch is made up of bull trout (McPhail and Baxter 1996, Reiman and McIntyre 1995). However, in Skookumchuck Creek, bull trout represented 72.4% and 49.6% of the catch in 2002 and 2003, respectively. Although the percentage of the total catch was lower for bull trout in 2003, the total catch of bull trout fry was notably higher and this resulted in higher mean annual density estimates across all index sites for 2003. This was especially true for site 3 where densities were significantly higher (8.8_{2002} versus 16.4_{2003} fish/100 m^2; $p<0.05$; Table 8). Typically, areas with combined fry and juvenile densities greater than 1.5 fish per 100 m^2 are cited as critical rearing areas (Goetz 1989). Site 3 was coincidently the preferred bull trout spawning reach and the enumeration of redds within Skookumchuck Creek increased from 132 in 2001 to 143 in 2002 (Figure 3). This represents an 8% increase and the larger increase in catch (33%) was attributed to higher survival. Higher survival was hypothesized due to the following; 1) Bull trout fry were significantly larger in 2003 (t-Test; $p<0.05$), even though sampling was conducted 8 days earlier in 2003, and 2) Freshet volume and duration were more moderate in 2003 compared to 2002 due to a comparatively warm and dry winter in 2002-2003 (Figure 8).

The decrease in catch composition of bull trout fry and juveniles in 2003 was due to a corresponding increase in Westslope cutthroat trout catch. Westslope cutthroat trout fry (n=34) were captured exclusively in sites 2 and 3 (the preferred bull trout spawning reaches). The capture of cutthroat trout fry in 2003 but not in 2002 was thought to represent an earlier date of emergence due to warmer water temperatures in 2003. Juveniles (n=30) were captured in all sample sites, however, Sandown Creek captures represented 76.7% of all juvenile captures and the observed juvenile density of 4.62 fish/100 m^2 was one of the highest ever recorded in the bull trout and fish habitat monitoring program within the Wigwam and White Rivers or the Skookumchuck Creek index sites (2000-2003). Sandown Creek clearly represents preferred summer rearing habitat for cutthroat trout juveniles.

Skookumchuck Creek is considered one of the premier Westslope cutthroat trout stream fisheries in the East Kootenay and, as observed in similar streams in the East Kootenay (Heidt 2003), appears to be experiencing a rapid increase in angling pressure due to its popularity, accessibility, and increased commercial guiding. Telemetry studies have identified angler harvest as the leading cause of mortality in East Kootenay Westslope cutthroat trout and the high incidence of released fish demonstrating sub-lethal effects (*i.e*. badly damaged or missing mouthparts/maxillary) may lead to further impacts (Prince and Morris 2003). Therefore, snorkel surveys were implemented in 2003 on mainstem Skookumchuck Creek index sites to target adult Westslope cutthroat trout and deep, mid-channel habitat that are not effectively sampled using existing electrofishing techniques. Sub-adult and adult Westslope cutthroat trout densities were 3.1 and 3.2 fish/100 lineal m for sites one and 3, respectively, while site 2 densities were 8.6 fish/100 lineal m. The high densities of adult cutthroat trout within site 2 were attributed to habitat quality and in particular the abundance of deep pool habitat. These densities appear very high, in comparison to the Wigwam River, another premier Westslope cutthroat trout stream in the East Kootenay. The highest density of Westslope cutthroat trout in the Wigwam River was 2.9 fish/ 100 lineal m (Baxter and Hagen 2003). Results of this comparison are probably somewhat biased as the snorkel sections on the Wigwam River were 3.5 to 7.5 times longer than that of the Skookumchuck sites, and as result the Skookumchuck results reflect the best available habitat within an individual reach.

Maximum summer water temperatures of 14 – 18^{o}C appear to limit bull trout distribution (Baxter and McPhail 1996) and the high water quality of the Skookumchuck Creek was reflected in the low maximum summer water temperatures and ubiquitous juvenile bull trout distribution. Trends in fry and juvenile abundance appeared to be related to:

- proximity to spawning areas;
- bed material size;
- water depth; and
- Cover.

The association of bull trout fry with shallow (5 – 20 cm), low velocity (<0.3 m/s), cobble dominated stream margin habitat has been previously documented within the Wigwam River (Cope 2003).

The range of morphological stream types for the mainstem Skookumchuck Creek encompasses the stable and resilient spectrum (C3(1) and C3). The Skookumchuck index sites can be generalized as a slightly entrenched, meandering, riffle-pool, cobble dominated channel with a well developed floodplain. The presence of an undisturbed, riparian ecosystem dominated by mature, coniferous forest, combined with a high percentage of coarse particles in the stream bank result in stable stream banks with low sediment supply. The results of the habitat assessment concur with the stable stream channel type and channel disturbance features noted were infrequent and minor in nature. The B3c classification of Site 3 in 2002 was the result of entrenchment increasing to just beyond the C3 range. The two meander lengths selected for survey are transitional between the B3 and C3 channel types as the reach approaches the falls 2.5 kilometers upstream. Replication of the riffle cross-section in the downstream meander confirmed this stream classification. Width to depth ratios appear to be high in Site 2 and movement of the cross-section from the bottom of the riffle to the top of the riffle had no effect on this ratio. This was attributed to site-specific anomalies related to the placement of the riffle cross-section with no replication.

Sandown Creek, in contrast, appears to be undergoing a successional evolution from an F4 stream type to a C4 stream type. Sandown Creek is undergoing a series of channel adjustments to accommodate changes or alterations to sediment supply. Disturbance indicators (*i.e*. sediment wedges, unvegetated bars, buried LWD) were indicative of increased bedload and an aggraded stream channel. The resultant channel aggradation or infilling resulted in an increased width to depth ratio and a lower entrenchment ratio. Currently, the previously over-widened bed of the F4 stream type is now the elevation of the new floodplain for the C4 stream type, which gradually incises, reducing the width to depth ratio and increasing the entrenchment ratio. The stream channel of Sandown Creek was a gravel dominated channel with a high proportion of sand and was noted for the lack of a mature riparian ecosystem. A large amount of old LWD was present within the stream channel with little or no evidence of recent LWD recruitment. LWD accumulations within the bankfull stream channel were often buried or formed large sediment wedges.

The estimated bankfull discharge for Skookumchuck Creek was 69.5 m^3/s based on an assumed return frequency of 1.5 years. Based on the estimated bankfull cross-sectional area and estimated “roughness” or mannings n, the predicted bankfull discharge was 52 m^3/s. This discrepancy was most likely due to a combination of the following; 1) the actual return frequency was lower than 1.5 (*i.e*. return frequency of 1.25 years equals 56 m^3/s), and 2) the bankfull elevation for the riffle cross-section was under-estimated.

In summary, the upper Skookumchuck can be characterized by stability and habitat heterogeneity. These reaches, with their high sinuosity, frequent deep pools, and high quality spawning and rearing habitat contain high densities of bull trout and Westslope cutthroat trout. When compared to other bull trout and Westslope cutthroat trout systems, the spawning escapement and fish densities provide a strong case that the Skookumchuck Creek bull trout and Westslope cutthroat trout represent a significant and stable population with high juvenile survival rates. Bull trout and Westslope cutthroat trout populations have been shown to be extremely susceptible to habitat degradation and over harvest (Liknes and Graham 1988, McPhail and Baxter 1996, Ratliff *et al*. 1996) and are ecologically important as an indicator of watershed health (Baxter 1997). As such, the upper Skookumchuck Creek watershed remains relatively pristine, and maintains high water quality and high habitat capability. After eighty years of forest development and public access within the Skookumchuck Creek watershed, conservative forest harvesting levels that preserved the riparian ecosystem and angling regulations designed to limit harvest have been successful in preventing habitat degradation or over-exploitation of the fishery.

5 Recommendations

The snorkel survey and the inclusion of the Sandown Creek index site have demonstrated their importance to Westslope cutthroat trout monitoring and have improved the applicability of the current monitoring program to Westslope cutthroat trout. These tasks should be permanently included in the Skookumchuck Creek bull trout and fish habitat-monitoring program.

6 References

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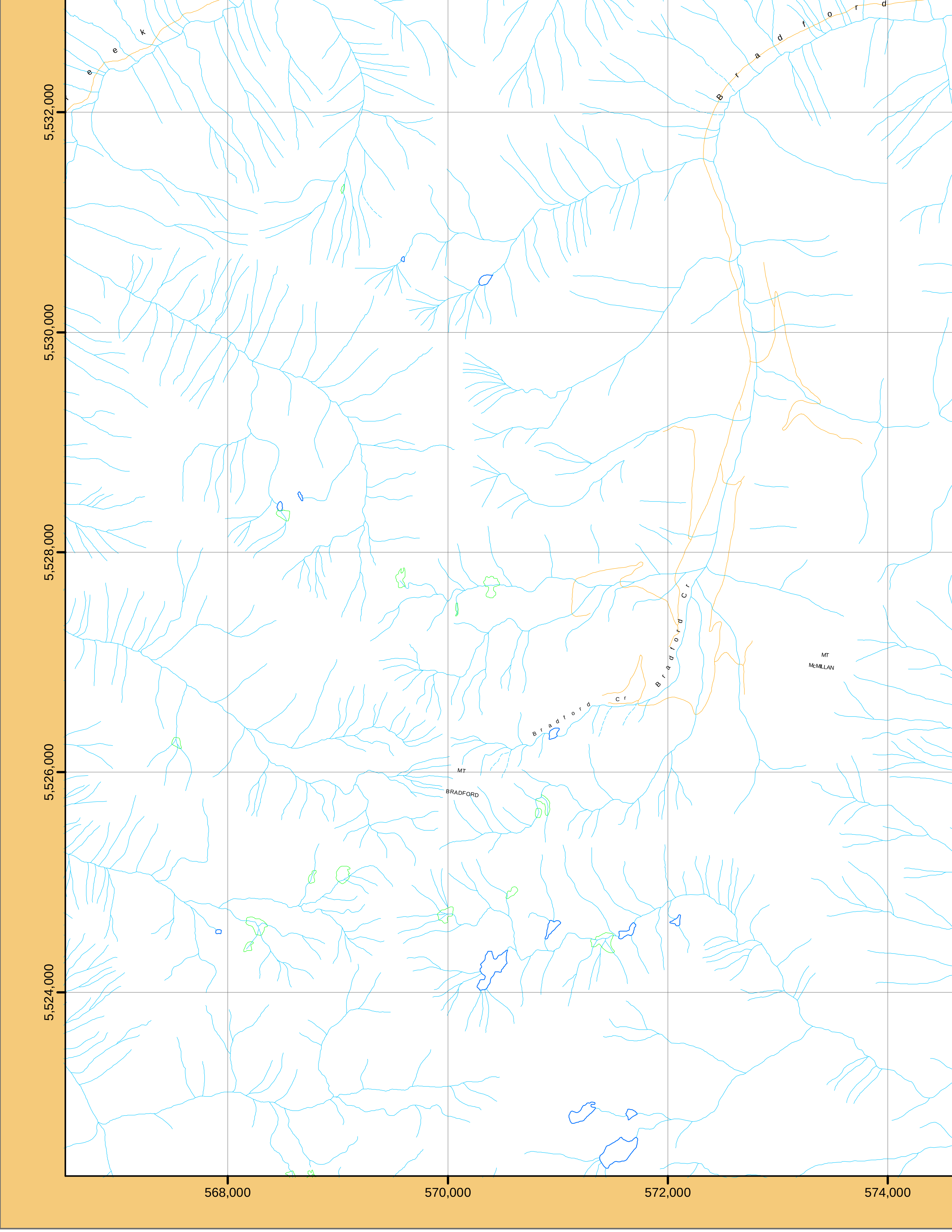
Appendix A

1:50,000 TRIM Map



5,532,000
5,530,000
5,528,000
5,526,000
5,524,000
568,000
570,000
572,000
574,000
Bradford
Bradford Cr
Bradford Cr
MT BRADFORD
MT McMILLAN

Appendix B

Fish Capture Data

FDIS Fish Card

		Reach #	ILP Map #	ILP #
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000	1.0		

WATERBODY

Gazetted Name: SKOOKUMCHUCK CREEK — Local: Skookumchuck (Pulp Mill Site)
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-0
WS Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: — ILP Map #: — ILP #: — Reach #: 1 -
Project ID: 10664 — Lake/Stream: S — Lake From Date:

Fish Permit #: 03-4-0977 — Date: 2003/08/04 — To: 2003/08/04 — Agency: C214 — Crew: AP/KM/SC — Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3			11	588414	5529766	GP3	EF	1	17.2	98	C	Riffle Margin
2			11	588451	5530088	GP3	EF	1	16.8	101	C	Glide Margin
1			11	588484	5530017	GP3	EF	1	16.8	101	C	Pool Margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/04	15:40	2003/08/04	16:26	Photos 7, 8, 9
1	EF	1	2	2003/08/04	16:29	2003/08/04	16:57	
1	EF	1	3	2003/08/04	17:00	2003/08/04	17:20	
2	EF	1	1	2003/08/04	17:53	2003/08/04	18:26	Photos 10, 11, 12
2	EF	1	2	2003/08/04	18:30	2003/08/04	19:24	
2	EF	1	3	2003/08/04	19:30	2003/08/04	20:02	
3	EF	1	1	2003/08/04	12:42	2003/08/04	13:06	Photos 4, 5, 6
3	EF	1	2	2003/08/04	13:14	2003/08/04	13:32	
3	EF	1	3	2003/08/04	13:39	2003/08/04	13:59	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1117	22.0	7.0	300	60	6	SR	12A
1	EF	1	2	C	987	22.0	7.0	300	60	6	SR	12A
1	EF	1	3	C	951	22.0	7.0	300	60	6	SR	12A
2	EF	1	1	C	1018	20.0	7.0	400	60	6	SR	12A
2	EF	1	2	C	1231	20.0	7.0	400	60	6	SR	12A
2	EF	1	3	C	831	20.0	7.0	400	60	6	SR	12A
3	EF	1	1	C	942	16.0	10.0	400	60	6	SR	12A
3	EF	1	2	C	1016	16.0	10.0	400	60	6	SR	12A
3	EF	1	3	C	932	16.0	10.0	400	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	WCT	J	1	1	71	71	R	
1	EF	1	1	CRH	J	U	2	44	48	R	
1	EF	1	1	LSU	J	U	1	58	58	R	
1	EF	1	1	BT	F	0	2	38	46	R	
1	EF	1	3	BT	F	0	1	57	57	R	
2	EF	1	1	WCT	J	1	1	78	78	R	
2	EF	1	1	MW	F	0	1	45	45	R	
2	EF	1	1	CRH	A	U	7	38	95	R	
2	EF	1	1	LSU	A	U	21	67	114	R	
2	EF	1	2	LSU	A	U	10	71	96	R	
2	EF	1	3	CRH	J	U	1	56	56	R	
2	EF	1	3	LSU	A	U	2	74	85	R	
3	EF	1	1	BT	F	0	3	41	52	R	
3	EF	1	1	BT	J	1	1	114	114	R	
3	EF	1	1	MW	F	0	1	46	46	R	
3	EF	1	1	LSU	A	U	5	77	103	R	
3	EF	1	2	MW	F	0	4	46	53	R	
3	EF	1	2	CRH	J	U	1	45	45	R	
3	EF	1	2	LSU	A	U	2	64	97	R	
3	EF	1	3	MW	F	0	2	50	58	R	
3	EF	1	3	CRH	J	U	1	40	40	R	

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 1.0

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	46	1.1	U	U			0						
1	EF	1	1	BT	38	.7	U	U			0						
1	EF	1	1	WCT	71	3.9	U	U			1						
1	EF	1	1	CRH	48	1.7	U	U									
1	EF	1	1	CRH	44	.9	U	U									
1	EF	1	1	LSU	58	1.8	U	U									
1	EF	1	3	BT	57	1.9	U	U			0						
2	EF	1	1	MW	45	.8	U	U			0						
2	EF	1	1	LSU	103	11.2	U	U									
2	EF	1	1	LSU	109	14.7	U	U									
2	EF	1	1	LSU	114	16.8	U	U									
2	EF	1	1	LSU	103	10.7	U	U									
2	EF	1	1	CRH	95	10.7	U	U									
2	EF	1	1	CRH	65	3.8	U	U									
2	EF	1	1	LSU	94	6.4	U	U									
2	EF	1	1	LSU	81	5.8	U	U									
2	EF	1	1	LSU	67	3.2	U	U									
2	EF	1	1	LSU	75	4.3	U	U									
2	EF	1	1	LSU	117	14.3	U	U									
2	EF	1	1	LSU	105	10.6	U	U									
2	EF	1	1	LSU	84	6.1	U	U									
2	EF	1	1	LSU	74	4.7	U	U									
2	EF	1	1	LSU	87	7.3	U	U									
2	EF	1	1	LSU	86	6.2	U	U									
2	EF	1	1	LSU	89	7.8	U	U									
2	EF	1	1	LSU	92	8.1	U	U									
2	EF	1	1	LSU	76	4.1	U	U									
2	EF	1	1	LSU	77	5.2	U	U									
2	EF	1	1	LSU	81	5.9	U	U									
2	EF	1	1	WCT	78	5.4	U	U			1						
2	EF	1	1	CRH	68	3.9	U	U									
2	EF	1	1	CRH	49	2.5	U	U									
2	EF	1	1	LSU	82	5.7	U	U									
2	EF	1	1	LSU	82	5.9	U	U									
2	EF	1	1	CRH	71	4.9	U	U									
2	EF	1	1	CRH	38		U	U									
2	EF	1	1	CRH	44		U	U									
2	EF	1	2	LSU	96	9.4	U	U									
2	EF	1	2	LSU	94	8.1	U	U									
2	EF	1	2	LSU	82	5.8	U	U									
2	EF	1	2	LSU	85	6.5	U	U									
2	EF	1	2	LSU	71	3.7	U	U									
2	EF	1	2	LSU	85	6.5	U	U									
2	EF	1	2	LSU	79	5.4	U	U									
2	EF	1	2	LSU	76	4.3	U	U									
2	EF	1	2	LSU	81	5.3	U	U									
2	EF	1	2	LSU	73	5.7	U	U									
2	EF	1	3	LSU	85		U	U									
2	EF	1	3	LSU	74		U	U									
2	EF	1	3	CRH	56		U	U									
3	EF	1	1	BT	114	14.2	U	U			1						
3	EF	1	1	BT	52	1.5	U	U			0						
3	EF	1	1	BT	49	1.3	U	U			0						
3	EF	1	1	MW	46	1.2	U	U			0						
3	EF	1	1	BT	41	.9	U	U			0						
3	EF	1	1	LSU	103	11.6	U	U									
3	EF	1	1	LSU	92	8.6	U	U									

FDIS Fish Card

		Reach #	ILP Map #	ILP #
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000	1.0		

INDIVIDUAL FISH DATA																	
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
3	EF	1	1	LSU	77	4.2	U	U									
3	EF	1	1	LSU	84	6.3	U	U									
3	EF	1	1	LSU	93	8.4	U	U									
3	EF	1	2	MW	53	1.8	U	U			0						
3	EF	1	2	MW	51	1.4	U	U			0						
3	EF	1	2	MW	52	1.6	U	U			0						
3	EF	1	2	CRH	45	1.3	U	U									
3	EF	1	2	MW	46	1.0	U	U			0						
3	EF	1	2	LSU	97	9.3	U	U									
3	EF	1	2	LSU	64	2.9	U	U									
3	EF	1	3	CRH	40	.8	U	U									
3	EF	1	3	MW	58	1.9	U	U			0						
3	EF	1	3	MW	50	1.3	U	U			0						

FDIS Fish Card

		Reach #	ILP Map #	ILP #
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000	2.0		

WATERBODY

Gazetted Name: SKOOKUMCHUCK CREEK   Local: Skookumchuck (km 38 FSR)
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-0
WS Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: ILP Map #:   ILP #:   Reach #: 2 -
Project ID: 10664   Lake/Stream: S   Lake From Date:

Fish Permit #: 03-4-0977   Date: 2003/08/06   To: 2003/08/06   Agency: C214   Crew: AP/KM/SC   Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3			11	575403	5536341	GP3	EF	1	12.8	45	C	Pool margin
2			11	575419	5536080	GP3	EF	1	11.8	69	C	Riffle margin
1			11	575264	5536093	GP3	EF	1	11.6	61	C	Glide Margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/06	09:10	2003/08/06	09:31	Photos 26, 27, 28
1	EF	1	2	2003/08/06	09:36	2003/08/06	09:58	
1	EF	1	3	2003/08/06	10:03	2003/08/06	10:18	
2	EF	1	1	2003/08/06	11:00	2003/08/06	11:32	Photos 32, 33, 34
2	EF	1	2	2003/08/06	11:36	2003/08/06	11:58	
2	EF	1	3	2003/08/06	12:00	2003/08/06	12:26	
3	EF	1	1	2003/08/06	14:55	2003/08/06	15:19	Photos 35, 36, 37
3	EF	1	2	2003/08/06	15:22	2003/08/06	15:43	
3	EF	1	3	2003/08/06	15:45	2003/08/06	16:05	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1018	27.0	6.0	400	60	6	SR	12A
1	EF	1	2	C	916	27.0	6.0	400	60	6	SR	12A
1	EF	1	3	C	847	27.0	6.0	400	60	6	SR	12A
2	EF	1	1	C	1321	32.0	5.7	400	60	6	SR	12A
2	EF	1	2	C	1012	32.0	5.7	400	60	6	SR	12A
2	EF	1	3	C	939	32.0	5.7	400	60	6	SR	12A
3	EF	1	1	C	1256	30.0	3.6	400	60	6	SR	12A
3	EF	1	2	C	913	30.0	3.6	400	60	6	SR	12A
3	EF	1	3	C	797	30.0	3.6	400	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	WCT	J	1	1	75	75	R	
1	EF	1	1	WCT	F	0	3	29	37	R	
1	EF	1	1	BT	F	0	2	46	59	R	
1	EF	1	2	WCT	F	0	2	27	36	R	
1	EF	1	2	BT	F	0	2	45	50	R	
1	EF	1	3	WCT	F	0	2	32	36	R	
2	EF	1	1	WCT	F	0	2	27	35	R	
2	EF	1	1	BT	J	1	2	82	92	R	
2	EF	1	1	BT	F	0	20	40	54	R	
2	EF	1	2	BT	F	0	11	35	55	R	
2	EF	1	3	WCT	F	0	3	26	33	R	
2	EF	1	3	BT	F	0	2	39	46	R	
3	EF	1	1	BT	F	0	5	38	48	R	
3	EF	1	2	WCT	F	0	1	30	30	R	
3	EF	1	2	BT	F	0	2	45	45	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	59	2.4	U	U			0						
1	EF	1	1	WCT	75	4.6	U	U			1						
1	EF	1	1	BT	46	1.0	U	U			0						

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 2.0

INDIVIDUAL FISH DATA																	
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	WCT	36	.6	U	U			0						
1	EF	1	1	WCT	29	.4	U	U			0						
1	EF	1	1	WCT	37	.5	U	U			0						
1	EF	1	2	BT	45	.9	U	U			0						
1	EF	1	2	WCT	36	.4	U	U			0						
1	EF	1	2	BT	50	1.2	U	U			0						
1	EF	1	2	WCT	27	.2	U	U			0						
1	EF	1	3	WCT	36	.4	U	U			0						
1	EF	1	3	WCT	32	.4	U	U			0						
2	EF	1	1	BT	42	.7	U	U			0						
2	EF	1	1	BT	47	1.3	U	U			0						
2	EF	1	1	BT	45	1.0	U	U			0						
2	EF	1	1	BT	51	1.2	U	U			0						
2	EF	1	1	BT	82	5.2	U	U			1						
2	EF	1	1	BT	44	1.1	U	U			0						
2	EF	1	1	BT	46	1.3	U	U			0						
2	EF	1	1	BT	46	1.0	U	U			0						
2	EF	1	1	BT	46	1.3	U	U			0						
2	EF	1	1	BT	51	1.2	U	U			0						
2	EF	1	1	BT	40	.7	U	U			0						
2	EF	1	1	WCT	27	.3	U	U			0						
2	EF	1	1	BT	48	1.4	U	U			0						
2	EF	1	1	WCT	35	.5	U	U			0						
2	EF	1	1	BT	92	9.3	U	U			1						
2	EF	1	1	BT	50	1.3	U	U			0						
2	EF	1	1	BT	49	1.3	U	U			0						
2	EF	1	1	BT	47	1.1	U	U			0						
2	EF	1	1	BT	52	1.5	U	U			0						
2	EF	1	1	BT	54	2.0	U	U			0						
2	EF	1	1	BT	52	1.7	U	U			0						
2	EF	1	1	BT	43	1.1	U	U			0						
2	EF	1	1	BT	42	.8	U	U			0						
2	EF	1	1	BT	42	.7	U	U			0						
2	EF	1	2	BT	49	1.6	U	U			0						
2	EF	1	2	BT	48	1.7	U	U			0						
2	EF	1	2	BT	44	.8	U	U			0						
2	EF	1	2	BT	48	1.2	U	U			0						
2	EF	1	2	BT	55	1.7	U	U			0						
2	EF	1	2	BT	48	1.3	U	U			0						
2	EF	1	2	BT	53	1.6	U	U			0						
2	EF	1	2	BT	52	1.5	U	U			0						
2	EF	1	2	BT	51	1.4	U	U			0						
2	EF	1	2	BT	50	1.5	U	U			0						
2	EF	1	2	BT	35	.5	U	U			0						
2	EF	1	3	BT	39	.7	U	U			0						
2	EF	1	3	WCT	26	.2	U	U			0						
2	EF	1	3	WCT	27	.1	U	U			0						
2	EF	1	3	WCT	33	.3	U	U			0						
2	EF	1	3	BT	46	.9	U	U			0						
3	EF	1	1	BT	48	1.3	U	U			0						
3	EF	1	1	BT	38	.7	U	U			0						
3	EF	1	1	BT	47	1.0	U	U			0						
3	EF	1	1	BT	47	1.2	U	U			0						
3	EF	1	1	BT	42	.8	U	U			0						
3	EF	1	2	BT	45	1.0	U	U			0						
3	EF	1	2	BT	45	1.0	U	U			0						
3	EF	1	2	WCT	30	.2	U	U			0						

FDIS Fish Card

		Reach #	ILP Map #	ILP #
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000	3.0		

WATERBODY

Gazetted Name: SKOOKUMCHUCK CREEK   Local: Skookumchuck (km 42.5 FSR)
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-0
WS Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: ILP Map #:   ILP #:   Reach #: 3 -
Project ID: 10664   Lake/Stream: S   Lake From Date:

Fish Permit #: 03-4-0977   Date: 2003/08/07   To: 2003/08/07   Agency: C214   Crew: AP/KM/SC   Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3			11	572405	5535125	GP3	EF	1	11	45	C	Glide Margin
2			11	572360	5535334	GP3	EF	1	11	45	C	Riffle margin
1			11	572245	5535476	GP3	EF	1	10.2	46	C	Pool Margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/07	08:20	2003/08/07	08:45	Photos 38, 39, 40
1	EF	1	2	2003/08/07	08:50	2003/08/07	09:08	
1	EF	1	3	2003/08/07	09:10	2003/08/07	09:27	
2	EF	1	1	2003/08/07	10:10	2003/08/07	10:39	Photos
2	EF	1	2	2003/08/07	10:41	2003/08/07	11:03	
2	EF	1	3	2003/08/07	11:05	2003/08/07	11:26	
3	EF	1	1	2003/08/07	13:22	2003/08/07	13:45	Photos 44, 45, 46, 47
3	EF	1	2	2003/08/07	13:47	2003/08/07	14:01	
3	EF	1	3	2003/08/07	14:05	2003/08/07	14:26	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1198	30.0	4.5	400	60	6	SR	12A
1	EF	1	2	C	1053	30.0	4.5	400	60	6	SR	12A
1	EF	1	3	C	848	30.0	4.5	400	60	6	SR	12A
2	EF	1	1	C	1218	29.2	5.4	400	60	6	SR	12A
2	EF	1	2	C	982	29.2	5.4	400	60	6	SR	12A
2	EF	1	3	C	863	29.2	5.4	400	60	6	SR	12A
3	EF	1	1	C	984	18.5	9.3	400	60	6	SR	12A
3	EF	1	2	C	765	18.5	9.3	400	60	6	SR	12A
3	EF	1	3	C	868	18.5	9.3	400	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	WCT	F	0	5	25	27	R	
1	EF	1	1	BT	F	0	17	44	52	R	
1	EF	1	2	BT	F	0	11	43	52	R	
1	EF	1	2	WCT	F	0	3	24	29	R	
1	EF	1	3	BT	F	0	4	47	54	R	
1	EF	1	3	WCT	F	0	1	27	27	R	
2	EF	1	1	WCT	J	1	1	67	67	R	
2	EF	1	1	BT	F	0	10	44	54	R	
2	EF	1	1	BT	J	1	1	93	93	R	
2	EF	1	1	WCT	F	0	2	24	26	R	
2	EF	1	2	BT	F	0	4	45	53	R	
2	EF	1	3	BT	F	0	3	45	54	R	
3	EF	1	1	BT	F	0	1	51	51	R	
3	EF	1	1	WCT	F	0	4	24	29	R	
3	EF	1	1	WCT	J	1	3	62	84	R	
3	EF	1	2	BT	F	0	3	38	51	R	
3	EF	1	2	WCT	F	0	4	21	28	R	
3	EF	1	3	WCT	F	0	2	26	28	R	
3	EF	1	3	BT	F	0	5	49	63	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO	H/P	Species	Length	Weight	Sex	Mat	Age	Vch#	Genetic	Roll #	Frame#	Comment

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 3.0

									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	46	1.0	U	U			0						
1	EF	1	1	BT	44	.8	U	U			0						
1	EF	1	1	BT	45	.8	U	U			0						
1	EF	1	1	WCT	26	.1	U	U			0						
1	EF	1	1	WCT	27	.1	U	U			0						
1	EF	1	1	BT	44	1.0	U	U			0						
1	EF	1	1	BT	45	1.0	U	U			0						
1	EF	1	1	BT	44	.9	U	U			0						
1	EF	1	1	BT	52	1.6	U	U			0						
1	EF	1	1	BT	46	.9	U	U			0						
1	EF	1	1	WCT	27	.1	U	U			0						
1	EF	1	1	WCT	25	.1	U	U			0						
1	EF	1	1	BT	52	1.6	U	U			0						
1	EF	1	1	BT	48	1.1	U	U			0						
1	EF	1	1	BT	49	1.1	U	U			0						
1	EF	1	1	BT	45	1.0	U	U			0						
1	EF	1	1	WCT	26	.1	U	U			0						
1	EF	1	1	BT	52	1.3	U	U			0						
1	EF	1	1	BT	44	1.0	U	U			0						
1	EF	1	1	BT	44	1.1	U	U			0						
1	EF	1	1	BT	47	1.0	U	U			0						
1	EF	1	1	BT	50	1.1	U	U			0						
1	EF	1	2	WCT	29	.1	U	U			0						
1	EF	1	2	WCT	24	.1	U	U			0						
1	EF	1	2	WCT	26	.1	U	U			0						
1	EF	1	2	BT	51	1.9	U	U			0						
1	EF	1	2	BT	46	1.1	U	U			0						
1	EF	1	2	BT	47	1.1	U	U			0						
1	EF	1	2	BT	44	.7	U	U			0						
1	EF	1	2	BT	52	1.8	U	U			0						
1	EF	1	2	BT	49	1.2	U	U			0						
1	EF	1	2	BT	49	1.3	U	U			0						
1	EF	1	2	BT	43	.8	U	U			0						
1	EF	1	2	BT	51	1.4	U	U			0						
1	EF	1	2	BT	51	1.4	U	U			0						
1	EF	1	2	BT	48	1.3	U	U			0						
1	EF	1	3	WCT	27	.1	U	U			0						
1	EF	1	3	BT	47	.9	U	U			0						
1	EF	1	3	BT	54	1.5	U	U			0						
1	EF	1	3	BT	48	1.1	U	U			0						
1	EF	1	3	BT	48	1.0	U	U			0						
2	EF	1	1	WCT	24	.3	U	U			0						
2	EF	1	1	WCT	67	3.8	U	U			1						
2	EF	1	1	BT	93	8.0	U	U			1						
2	EF	1	1	BT	44	1.0	U	U			0						
2	EF	1	1	BT	54	1.6	U	U			0						
2	EF	1	1	BT	48	1.2	U	U			0						
2	EF	1	1	BT	54	1.7	U	U			0						
2	EF	1	1	BT	48	1.1	U	U			0						
2	EF	1	1	WCT	26	.3	U	U			0						
2	EF	1	1	BT	46	1.5	U	U			0						
2	EF	1	1	BT	44	1.1	U	U			0						
2	EF	1	1	BT	46	1.1	U	U			0						
2	EF	1	1	BT	49	1.4	U	U			0						
2	EF	1	1	BT	48	1.4	U	U			0						
2	EF	1	2	BT	45	1.2	U	U			0						
2	EF	1	2	BT	45	1.7	U	U			0						
2	EF	1	2	BT	47	1.5	U	U			0						
2	EF	1	2	BT	53	2.0	U	U			0						

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 3.0

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
2	EF	1	3	BT	52	2.0	U	U			0						
2	EF	1	3	BT	54	2.1	U	U			0						
2	EF	1	3	BT	45	1.3	U	U			0						
3	EF	1	1	WCT	25	.2	U	U			0						
3	EF	1	1	WCT	62	2.7	U	U			1						
3	EF	1	1	BT	51	1.2	U	U			0						
3	EF	1	1	WCT	68	3.4	U	U			1						
3	EF	1	1	WCT	24	.1	U	U			0						
3	EF	1	1	WCT	25	.1	U	U			0						
3	EF	1	1	WCT	84	5.9	U	U			1						
3	EF	1	1	WCT	29	.3	U	U			0						
3	EF	1	2	BT	38	.6	U	U			0						
3	EF	1	2	BT	49	1.5	U	U			0						
3	EF	1	2	WCT	28	.2	U	U			0						
3	EF	1	2	BT	51	1.4	U	U			0						
3	EF	1	2	WCT	21	.1	U	U			0						
3	EF	1	2	WCT	26	.2	U	U			0						
3	EF	1	2	WCT	27	.2	U	U			0						
3	EF	1	3	BT	50	1.2	U	U			0						
3	EF	1	3	BT	49	1.2	U	U			0						
3	EF	1	3	BT	52	1.3	U	U			0						
3	EF	1	3	WCT	26	.2	U	U			0						
3	EF	1	3	BT	51	1.3	U	U			0						
3	EF	1	3	BT	63	2.5	U	U			0						
3	EF	1	3	WCT	28	.2	U	U			0						

FDIS Fish Card

	Reach #	ILP Map #	ILP #
Watershed Code: 349-524200-32800-00000-0000-0000-000-000-000-000-000-000	1.0		

WATERBODY

Gazetted Name: SANDOWN CREEK — Local: Sandown Creek
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-0
WS Code: 349-524200-32800-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: — ILP Map #: — ILP #: — Reach #: 1 -
Project ID: 10664 — Lake/Stream: S — Lake From Date:

Fish Permit #: 03-4-0977 — Date: 2003/08/05 — To: 2003/08/05 — Agency: C214 — Crew: AP/KM/SC — Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
4			11	580441	5539802	GP3	EF	1	14.2	221	C	Riffle (coarser)
3			11	580382	5539759	GP3	EF	1	13.1	214	C	Pool
2			11	580442	5539780	GP3	EF	1	11.9	213	C	Glide
1			11	580481	5539745	GP3	EF	1	9.3	204	C	Riffle

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/05	10:00	2003/08/05	10:50	Photo 15, 14, 13
1	EF	1	2	2003/08/05	10:56	2003/08/05	11:15	
1	EF	1	3	2003/08/05	11:20	2003/08/05	12:00	
2	EF	1	1	2003/08/05	12:15	2003/08/05	12:55	Photo 16, 17, 18
2	EF	1	2	2003/08/05	13:00	2003/08/05	13:31	
2	EF	1	3	2003/08/05	13:35	2003/08/05	14:00	
3	EF	1	1	2003/08/05	14:05	2003/08/05	14:28	Photo 21, 20, 19
3	EF	1	2	2003/08/05	14:35	2003/08/05	14:55	
3	EF	1	3	2003/08/05	14:55	2003/08/05	15:15	
4	EF	1	1	2003/08/05	16:00	2003/08/05	16:25	Photo 25, 24, 23, 22
4	EF	1	2	2003/08/05	16:25	2003/08/05	16:40	
4	EF	1	3	2003/08/05	16:40	2003/08/05	16:55	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	921	27.0	5.2	300	60	6	SR	12A
1	EF	1	2	C	733	27.0	5.2	300	60	6	SR	12A
1	EF	1	3	C	743	27.0	5.2	300	60	6	SR	12A
2	EF	1	1	C	895	26.0	4.0	300	60	6	SR	12A
2	EF	1	2	C	881	26.0	4.0	300	60	6	SR	12A
2	EF	1	3	C	866	26.0	4.0	300	60	6	SR	12A
3	EF	1	1	C	617	26.5	4.6	300	60	6	SR	12A
3	EF	1	2	C	674	26.5	4.6	300	60	6	SR	12A
3	EF	1	3	C	454	26.5	4.6	300	60	6	SR	12A
4	EF	1	1	C	807	33.0	4.0	300	60	6	SR	12A
4	EF	1	2	C	586	33.0	4.0	300	60	6	SR	12A
4	EF	1	3	C	585	33.0	4.0	300	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	BT	J	1	1	99	99	R	
1	EF	1	1	WCT	J	1	6	65	93	R	
1	EF	1	1	WCT	J	2	2	110	120	R	
1	EF	1	1	BT	F	0	1	55	55	R	
1	EF	1	2	WCT	J	1	1	65	65	R	
2	EF	1	1	WCT	J	2	1	165	165	R	
2	EF	1	1	BT	F	0	2	44	45	R	
2	EF	1	1	BT	J	1	1	110	110	R	
2	EF	1	2	WCT	J	1	1	71	71	R	
2	EF	1	2	BT	F	0	1	52	52	R	
2	EF	1	3	WCT	J	1	1	63	63	R	
3	EF	1	1	WCT	J	3	2	205	210	R	
3	EF	1	1	BT	J	2	1	171	171	R	
3	EF	1	1	WCT	J	1	1	68	68	R	

FDIS Fish Card

Watershed Code:		Reach #	ILP Map #	ILP #
	349-524200-32800-00000-0000-0000-000-000-000-000-000-000	1.0		

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
3	EF	1	2	BT	J	1	1	107	107	R	
4	EF	1	1	BT	F	0	1	47	47	R	
4	EF	1	1	WCT	J	1	4	52	85	R	
4	EF	1	1	WCT	J	3	1	235	235	R	
4	EF	1	2	WCT	J	1	1	90	90	R	
4	EF	1	2	WCT	J	2	1	140	140	R	
4	EF	1	2	BT	F	0	1	49	49	R	
4	EF	1	2	BT	J	1	1	106	106	R	
4	EF	1	3	WCT	J	1	1	74	74	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	WCT	75	4.9	U	U			1						
1	EF	1	1	WCT	65	3.2	U	U			1						
1	EF	1	1	WCT	120	19.6	U	U			2						
1	EF	1	1	BT	99	11.4	U	U			1						
1	EF	1	1	WCT	93	8.6	U	U			1						
1	EF	1	1	WCT	110	14.1	U	U			2						
1	EF	1	1	WCT	85	7.0	U	U			1						
1	EF	1	1	WCT	67	3.4	U	U			1						
1	EF	1	1	WCT	71	4.2	U	U			1						
1	EF	1	1	BT	55	1.8	U	U			0						
1	EF	1	2	WCT	65	3.0	U	U			1						
2	EF	1	1	WCT	165	51.9	U	U			2						
2	EF	1	1	BT	44	.8	U	U			0						
2	EF	1	1	BT	110	12.9	U	U			1						
2	EF	1	1	BT	45	.9	U	U			0						
2	EF	1	2	WCT	71	3.6	U	U			1						
2	EF	1	2	BT	52	1.6	U	U			0						
2	EF	1	3	WCT	63	2.4	U	U			1						
3	EF	1	1	WCT	68	3.7	U	U			1						
3	EF	1	1	WCT	205	111.0	U	U			3						
3	EF	1	1	WCT	210	115.8	U	U			3						
3	EF	1	1	BT	171	47.5	U	U			2						
3	EF	1	2	BT	107	12.2	U	U			1						
4	EF	1	1	WCT	85	6.2	U	U			1						
4	EF	1	1	BT	47	.9	U	U			0						
4	EF	1	1	WCT	68	3.2	U	U			1						
4	EF	1	1	WCT	235	144.2	U	U			3						
4	EF	1	1	WCT	52	1.5	U	U			1						
4	EF	1	1	WCT	84	5.8	U	U			1						
4	EF	1	2	WCT	90	7.9	U	U			1						
4	EF	1	2	BT	106	12.4	U	U			1						
4	EF	1	2	WCT	140	25.9	U	U			2						
4	EF	1	2	BT	49	1.2	U	U			0						
4	EF	1	3	WCT	74	4.3	U	U			1						

COMMENTS

Section	Comments
WATERBODY	Observed very small (< 25 mm) WCT fry that went through the mesh and lost

Appendix C

FHAP Level 1 Form 4 Data

Level 1 - Habitat Summary Diagnosis Report

Form Number:	Forest District	
100	Watershed Name:	SKOOKUMCHUCK CREEK
	Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000

Survey Date:	8/17/2003		Weather:	cloudy/smokey	Survey Crew:	SC/KM
Discharge:	5.21	(cubic meters per second)				

Subsampling Fractions:

Riffles	Pools	Glides	Cascades	Other
1 in 1	1 in 1	1 in 1	1 in 1	1 in 1

NTS Maps (1:50,000) :	BGGS Maps (1:20,000) :
ENTER	082F100
082G13	082K010
082F16	082F090
	082J001

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
1	KOOKUMCHUC	1	1				10	R	1	56	0.802	1.32	0.71	24.5	19.5	
Comments :																
2	KOOKUMCHUC	1	1				66	G	1	37	0.227	1.34	0.67	28	23	
Comments :																
3	KOOKUMCHUC	1	1				100	R	1	120	0.788	1.4	0.72	23.1	20	
Comments :																
4	KOOKUMCHUC	1	1				220	P	1	48	0.188	1.72	1.03	28.1	25.2	1.07
Comments :																

Form Number:
100

Bed Material Type						Total LWD Tally	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Rip
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt		10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type
C	B	300	M	R	L	0				B	5									S
C	G	250	M	R	L	0				B	5	OV	5							S
B	C	350	M	R	N	1				B	20						EB			S
C	B	300	M	R	N	0				B	20	DP	20							S

Level 1 - Habitat Summary Diagnosis Report

5	KOOKUMCHUC	1	1	11	588463	5529778	268	R	1	272	0.814	1.12	0.44	31	29.3	

Comments :

6	KOOKUMCHUC	1	1	11	588383	5529899	540	P	1	100	0.111	2.15	1.25	22.3	17.2	1.5

Comments :

7	KOOKUMCHUC	1	1				640	G	1	27	0.226	1.45	0.78	27.2	22.2	

Comments :

8	KOOKUMCHUC	1	1				667	R	1	148	0.784	1.11	0.41	34.5	32.5	

Comments :

9	KOOKUMCHUC	1	1	11	588447	5530138	815	P	1	85	0.119	1.87	1.11	23.8	17.7	1.2

Comments :

Very large eroding outside terrace

10	KOOKUMCHUC	1	1				900	R	1	30	1.149	1.6	0.78	25.9	22.9	

Comments :

11	KOOKUMCHUC	1	1				930	P	1	50	0.205	1.9	1.1	23.5	17	1.25

Comments :

C	B	300	M	R	N	1	1			B	10	OV	5							M
C	R	250	M	R	L	3	3			DP	25	B	15							M
C	G	250	M	R	L	1				B	5	C	2							M
C	B	300	M	R	L	57	23	15	7	C	10	B	2	SC	G	40	MB	MC	EB	M
G	C	200	L	R	H	2			2	B	15	C	10				EB			M
C	B	300	M	R	N	1				B	10	OV	5				EB			M
C	B	300	M	R	N	1				B	20	DP	20				EB			M

Level 1 - Habitat Summary Diagnosis Report

Form Number:	101
Forest District	
Watershed Name:	SKOOKUMCHUCK CREEK
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Survey Date:	10/29/2003
Weather:	overcast
Survey Crew:	sc/km
Discharge:	4.79 (cubic meters per second)

Subsampling Fractions:

Riffles	Pools	Glides	Cascades	Other
1 in 1	1 in 1	1 in 1	1 in 1	1 in 1

NTS Maps (1:50,000) :	BGGS Maps (1:20,000) :
082G13	082F100
082F16	082K010
	082F090
	082J001

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
1	KOOKUMCHUC	2	2	11	575209	5536239	4	R	1	58	0.819	1.17	0.49	30.5	17	
Comments :																
2	KOOKUMCHUC	2	2				16	P	3	27	0.041	1.35	0.93	33	16	1
Comments :																
3	KOOKUMCHUC	2	2				62	P	1	68	0.126	1.58	0.93	28	13	1
Comments :																
4	KOOKUMCHUC	2	2				130	G	1	28	0.135	1.27	0.66	30	26	
Comments :																

Form Number:
101

Bed Material Type						Total LWD Tally	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Rip
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt		10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type
C	B	300	L	R	L	5				B	8			SC	P	400				C
G	C	250	L	R	L					B	2			SC	P	50				C
G	C	250	L	R	H	2				B	5						DW	EB		C
G	C	250	L	R	H	2				B	5						DW	EB		C

Level 1 - Habitat Summary Diagnosis Report

5	KOOKUMCHUC	2	2				158	R	1	50	0.499	1.22	0.65	23	15	

Comments :

groundwater upwelling

6	KOOKUMCHUC	2	2	11	575261	5536154	208	P	1	70	0	2.89	2.3	43.6	33.2	2.7

Comments :

pool x-sectn

7	KOOKUMCHUC	2	2	11	575264	5536093	278	R	1	70	0.806	0.989	0.44	45	35	

Comments :

Ef Glide at top of riffle - transverse bar forming below pool

8	KOOKUMCHUC	2	2				348	P	1	36	0.088	1.5	1.28	28	18	1.5

Comments :

Heavy filamentous Algae. Groundwater input/minerals?

9	KOOKUMCHUC	2	2	11	575451	5536205	395	R	1	63	0.818	1.01	0.49	31.7	20.8	

Comments :

riffle x-sectn

10	KOOKUMCHCU	2	2				458	P	1	42	0.078	2.49	1.87	27	21	2.55

Comments :

11	OOKUMCHCU	2	2				500	G	1	20	0.04	1.33	0.74	35	25	

Comments :

12	KOOKUMCHUC	2	2				520	R	1	80	0.636	1.14	0.54	34.7	24.9	

Comments :

s/c at start exits here

13	KOOKUMCHUC	2	2	11	575403	5536341	600	P	1	70	0.042	1.91	1.46	25	17	1.6

Comments :

14	KOOKUMCHUC	2	2				670	G	1	25	0.045	1.3	0.74	30	22	

Comments :

C	G	300	L	R	L	1				B	2									C
G	C	250	L	R	H	9	2	1		DP	80	B	5							C
G	C	250	L	R	H	5	2	1		B	3	LWD	2							C
B	C	350	L	R	N	4				B	30	DP	30							C
B	C	350	L	R	N	3		1		B	10	SWD	2				DW			C
G	C	250	L	R	L	1				B	15	DP	45							C
C	G	300	L	R	L	6	4	2		LWD	5	B	3				DW	EB		C
C	G	300	L	R	L	4				B	10	SWD	3							C
G	C	250	L	R	L	5	3	2		B	5	LWD	2				EB			C
C	G	300	L	R	L					B	2						DW	EB		C

Level 1 - Habitat Summary Diagnosis Report

15	KOOKUMCHUC	2	2				695	R	1	115	0.795	1.07	0.45	33.5	25.2	

Comments :

16	KOOKUMCHUC	2	2				810	P	1	60	0.012	1.49	1.05	24	20	1.1

Comments :

17	KOOKUMCHUC	2	2	11	575704	5536300	870	G	1	30	0.137	1.02	0.61	28.2	25.4	

Comments :

B	C	350	L	R	L	6	1	2		B	20	OV	3				DW			C
G	C	250	L	R	H	2	2			B	10	OV	5							C
G	C	250	L	R	H					B	2	OV	2							C

Level 1 - Habitat Summary Diagnosis Report

Form Number:	102	Forest District	
		Watershed Name:	SKOOKUMCHUCK CREEK
		Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000

Survey Date:	10/28/2003		Weather:	overcast/snow	Survey Crew:	sc/km
Discharge:	4.16	(cubic meters per second)				

Subsampling Fractions:

Riffles		Pools		Glides		Cascades		Other	
1 in 1		1 in 1		1 in 1		1 in 1		1 in 1	

NTS Maps (1:50,000) :	BGGS Maps (1:20,000) :
082G13	082F100
082F16	082K010
	082F090
	082J001

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
1	KOOKUMCHUC	3	3	11	572178	5535070	0	R	1	125	1.026	1.19	0.52	36.6	16.3	

Comments :

riffle x-section

Detail No	Sub Basin Name	Reach No	Section No	Zone	Easting	Northing	Distance (m)	Type	Cat	Length (m)	Grad (%)	Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
2	KOOKUMCHUC	3	3	11	572183	5535065	125	P	1	35	0.126	1.39	0.86	38	12	0.95

Comments :

Detail No	Sub Basin Name	Reach No	Section No	Zone	Easting	Northing	Distance (m)	Type	Cat	Length (m)	Grad (%)	Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
3	KOOKUMCHUC	3	3				160	G	1	10	0.34	1.13	0.55	40	30	

Comments :

Detail No	Sub Basin Name	Reach No	Section No	Zone	Easting	Northing	Distance (m)	Type	Cat	Length (m)	Grad (%)	Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
4	KOOKUMCHUC	3	3				170	R	1	60	0.813	1.18	0.43	39	36	

Comments :

Start Braid and spawning BT redds

Form Number:
102

Bed Material Type						Total LWD Tally	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Rip
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt		10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type
C	B	300	L	R	L	4	2	1		C	5	B	3							C
C	G	250	L	R	L	4	4			C	5	OV	5				DW	MB	MC	C
C	G	250	L	R	L					C	3						DW	MB	MC	C
C	G	250	L	R	L	4	2	2		LWD	3	OV	2				MB			C

Level 1 - Habitat Summary Diagnosis Report

5	KOOKUMCHUC	3	3				170	G	3	30	0.15	1.1	0.41	38	27	

Comments :

Bt spawning

6	KOOKUMCHUC	3	3				180	P	3	20	0.2	1.18	0.75	38	27	0.8

Comments :

7	KOOKUMCHUC	3	3				230	P	1	66	0.002	1.83	1.31	26.6	16.1	1.4

Comments :

8	KOOKUMCHUC	3	3	11	572405	5535125	296	G	1	29	0.197	1.16	0.65	26.6	25.7	

Comments :

EF Glide

9	KOOKUMCHUC	3	3	11	572360	5535334	325	R	1	135	0.532	1.16	0.59	41.8	15.3	

Comments :

EF Riffle

10	KOOKUMCHUC	3	3				460	P	1	50	0.08	1.57	0.97	28.7	20	1

Comments :

11	KOOKUMCHUC	3	3				510	G	1	30	0.09	1.22	0.61	30.2	24.5	

Comments :

12	KOOKUMCHUC	3	3				540	R	1	90	0.798	1.05	0.48	31.7	27	

Comments :

Transverse bar

13	KOOKUMCHUC	3	3	11	572245	5535476	630	P	1	70	0.096	1.49	0.93	24.4	14.6	1.1

Comments :

EF pool

14	KOOKUMCHUC	3	3				700	G	1	50	0.24	1.31	0.66	25.6	18.5	

Comments :

G	C	200	L	R	H					C	2	OV	3				DW	MB	MC	C
G	C	200	L	R	H	1	1			LWD	5	OV	10							C
G	C	250	L	R	L					DP	50	B	15				EB			C
G	C	200	L	R	H					OV	5	B	10							C
C	B	300	L	R	N	13	8	4		OV	10	B	2	SC	P	111	MB			C
C	G	250	L	R	L	5			1	C	5	DP	20							C
G	C	200	L	R	H	1		1		OV	7	B	2							C
C	G	250	L	R	L	10	5	3	1	LWD	5	OV	5				DW			C
C	G	250	L	R	L	8	3	2		OV	15	DP	20							C
C	G	250	L	R	L	2				OV	10	B	2							C

Level 1 - Habitat Summary Diagnosis Report

15	KOOKUMCHUC	3	3				750	P	1	36	0	1.51	0.87	25.1	18.9	0.9

Comments :

16	KOOKUMCHUC	3	3				786	P	1	104	0.152	1.47	0.62	31.6	30.9	

Comments :

Added unit in 2003 survey

G	C	200	L	R	H	4	3	1		LWD	10	OV	5				EB			C
C	G	250	L	R	L	11	6	1		LWD	2	OV	5	SC	G	80	MC			C

Level 1 - Habitat Summary Diagnosis Report

Form Number:	103	Forest District	INVERMERE
		Watershed Name:	SANDOWN CREEK
		Watershed Code:	349-524200-32800-00000-0000-0000-000-000-000-000-000-000

Survey Date:	8/14/2003	Weather:	sunny/hot	Survey Crew:	sc/km
Discharge:	0.18	(cubic meters per second)			

Subsampling Fractions:

Riffles	Pools	Glides	Cascades	Other
1 in 1	1 in 1	1 in 1	1 in 1	1 in 1

NTS Maps (1:50,000) :	BGGS Maps (1:20,000) :
ENTER	082F100
082G13	082K010
082F16	082F090
	082J001

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth
1	SANDOWN	4	4	11	580437	5539883	6	R	1	6	2.236	0.6	0.16	5.7	3.7	
Comments :																
2	SANDOWN	4	4				12	P	1	7	0.274	0.97	0.54	9.2	8.1	0.61
Comments :																
3	SANDOWN	4	4				19	R	1	9	1.163	0.66	0.21	9.6	3.5	
Comments :																
4	SANDOWN	4	4				28	P	1	7	0.045	0.96	0.54	7.5	3.9	0.6
Comments :																

Form Number:
103

Bed Material Type						Total LWD Tally	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Rip
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt		10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type
G	S	50	L	R	H					SWD	5	OV	5				DW	WG		D
S	G	20	L	R	L	7	4	2		LWD	10	SWD	20				WG			D
G	S	70	L	R	H	4	4			LWD	8	SWD	20				DW			D
S	G	20	L	R	L					SWD	10	OV	10				DW			M

Level 1 - Habitat Summary Diagnosis Report

5	SANDOWN	4	4				35	R	1	17	1.363	0.8	0.38	7.1	3.8	0.4

Comments :

6	SANDOWN	4	4				52	P	1	22	0.157	0.85	0.42	5.6	3.8	0.5

Comments :

7	SANDOWN	4	4	11	580440	5539829	74	R	1	25	0.852	0.65	0.22	9.4	4.5	

Comments :

riffle xsectn and start EF

8	SANDOWN	4	4				99	P	1	6	0.3	1.16	0.7	7.1	4.1	0.76

Comments :

9	SANDOWN	4	4				105	R	1	7	0.929	0.62	0.2	5.7	3.4	

Comments :

10	SANDOWN	4	4	11	580444	5539801	112	P	1	6	0.083	1.1	0.64	6.4	4.3	0.7

Comments :

pool x-section

11	SANDOWN	4	4				118	R	1	4	1.925	0.53	0.16	8.3	4	

Comments :

12	SANDOWN	4	4				122	P	1	7	0.171	1.05	0.69	8.5	3.4	0.75

Comments :

13	SANDOWN	4	4				129	G	1	31	0.145	0.65	0.24	5.8	4.4	

Comments :

14	SANDOWN	4	4	11	580481	5539745	160	R	1	28	0.768	0.6	0.18	7	4.8	

Comments :

end Ef site

S	G	250	L	R	H	18	10	3		LWD	20	B	30							M
G	S	250	L	R	H	14	11			LWD	15	B	5				DW	EB		M
G	S	50	L	R	H	14	4	3		LWD	5	OV	5				DW			M
S	G	20	L	R	L	2				DP	60	SWD	10							M
G	S	50	L	R	H	1				SWD	10	C	5							M
S	G	20	L	R	H	15	9	6		LWD	40	DP	30							M
G	S	50	L	R	H	2				SWD	10	C	5				DW			D
S	G	20	L	R	L	3				OV	15	DP	25				DW			D
G	S	50	L	R	H	8	3			OV	10	LWD	5							D
G	S	50	L	R	H	19	10	7		LWD	10	OV	5				DW			D

Level 1 - Habitat Summary Diagnosis Report

15	SANDOWN	4	4				167	P	3	4	0.2	0.7	0.31	6.8	5.1	0.38

Comments :

16	SANDOWN	4	4				188	R	1	10	1.282	0.55	0.16	6.7	4	

Comments :

17	SANDOWN	4	4				198	P	1	12	0.163	1.05	0.53	9.1	6.4	0.6

Comments :

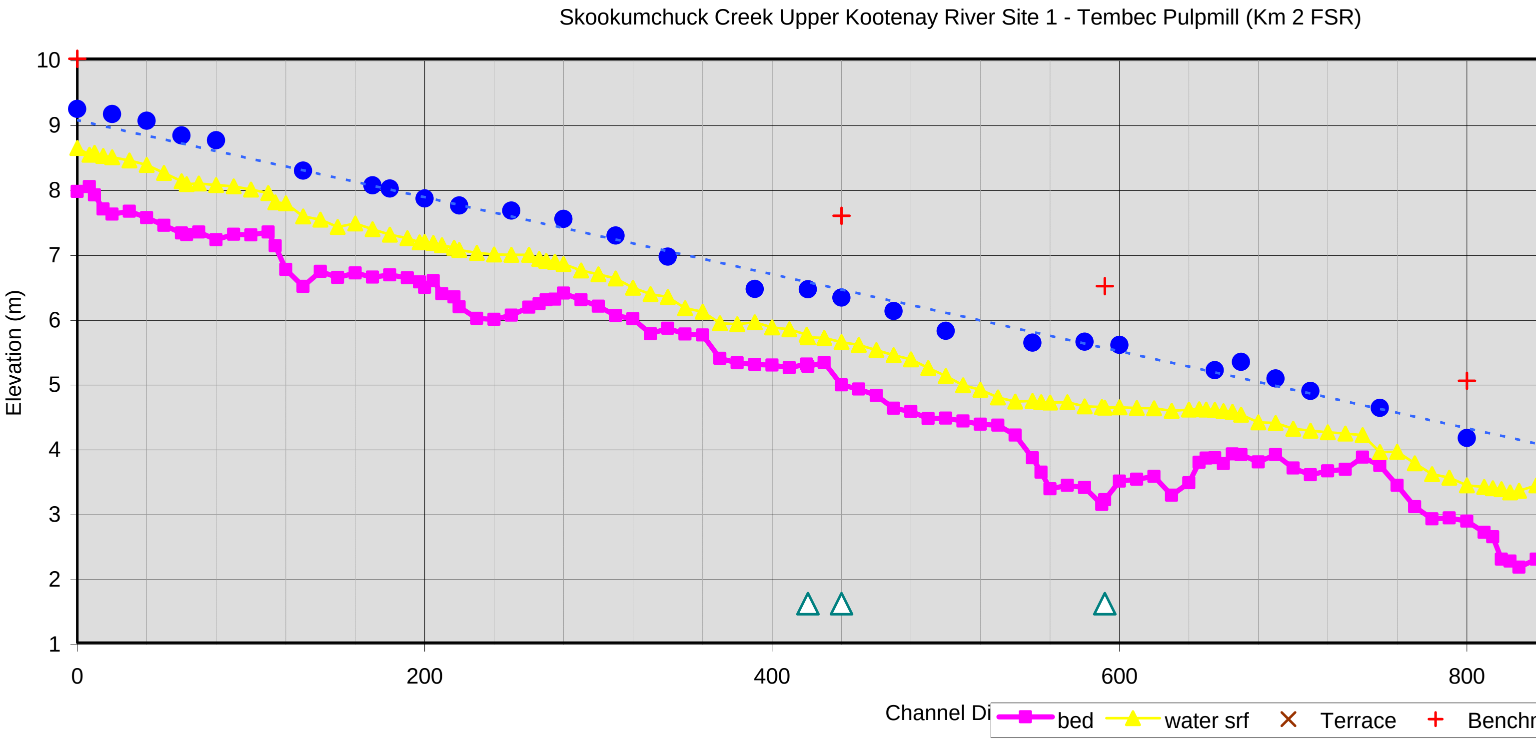
18	SANDOWN	4	4	11	580480	5539730	210	G	1	5	0.26	0.74	0.29	6.6	4.2	

Comments :

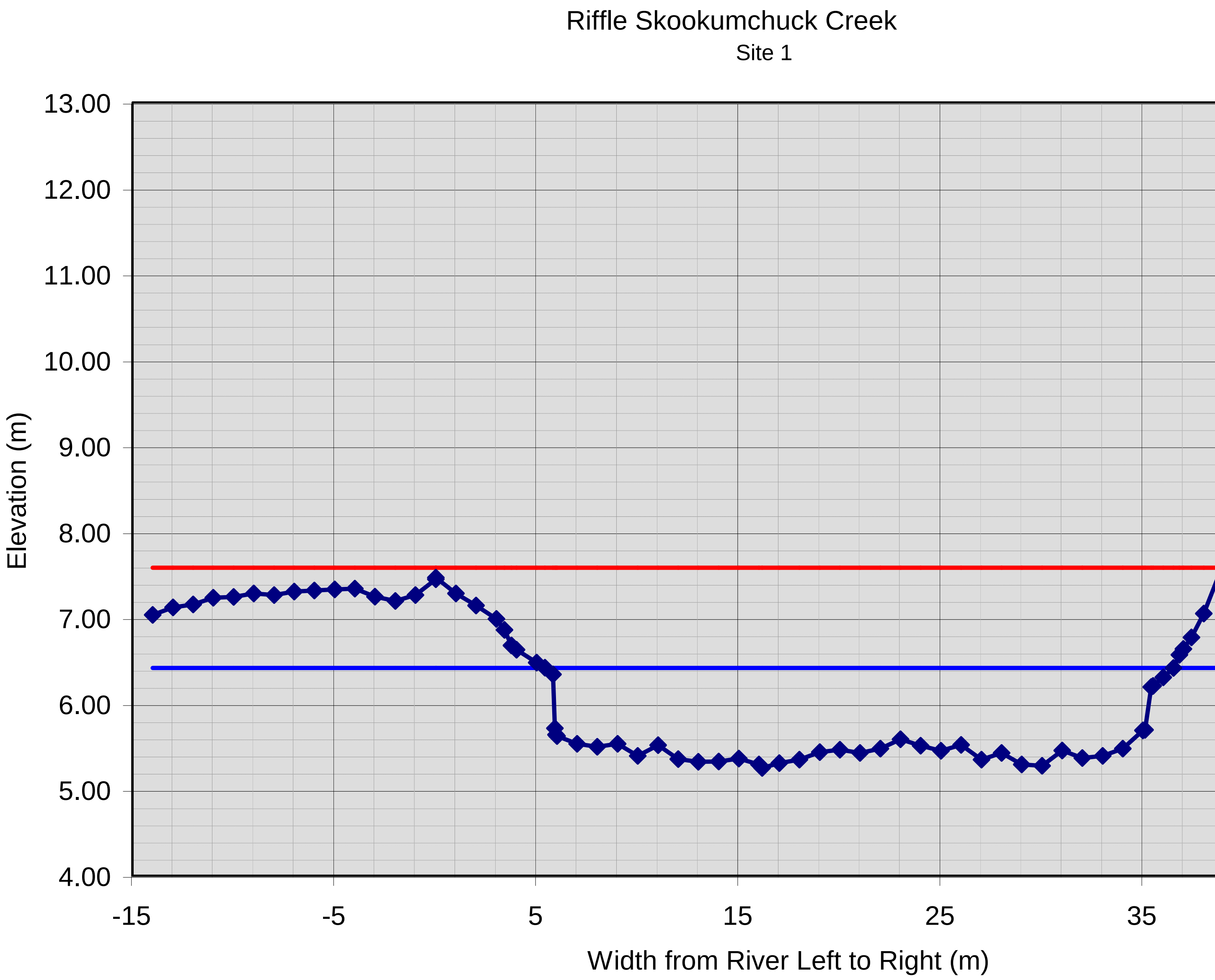
S	G	20	L	R	L	4		3		LWD	60	OV	20							D
G	S	50	L	R	H	0				SWD	10						DW			D
S	G	20	L	R	L	5	2			SWD	30	OV	15				WG	DW		D
S	G	20	L	R	L	0				OV	20	SWD	10				WG	DW		D

Appendix D

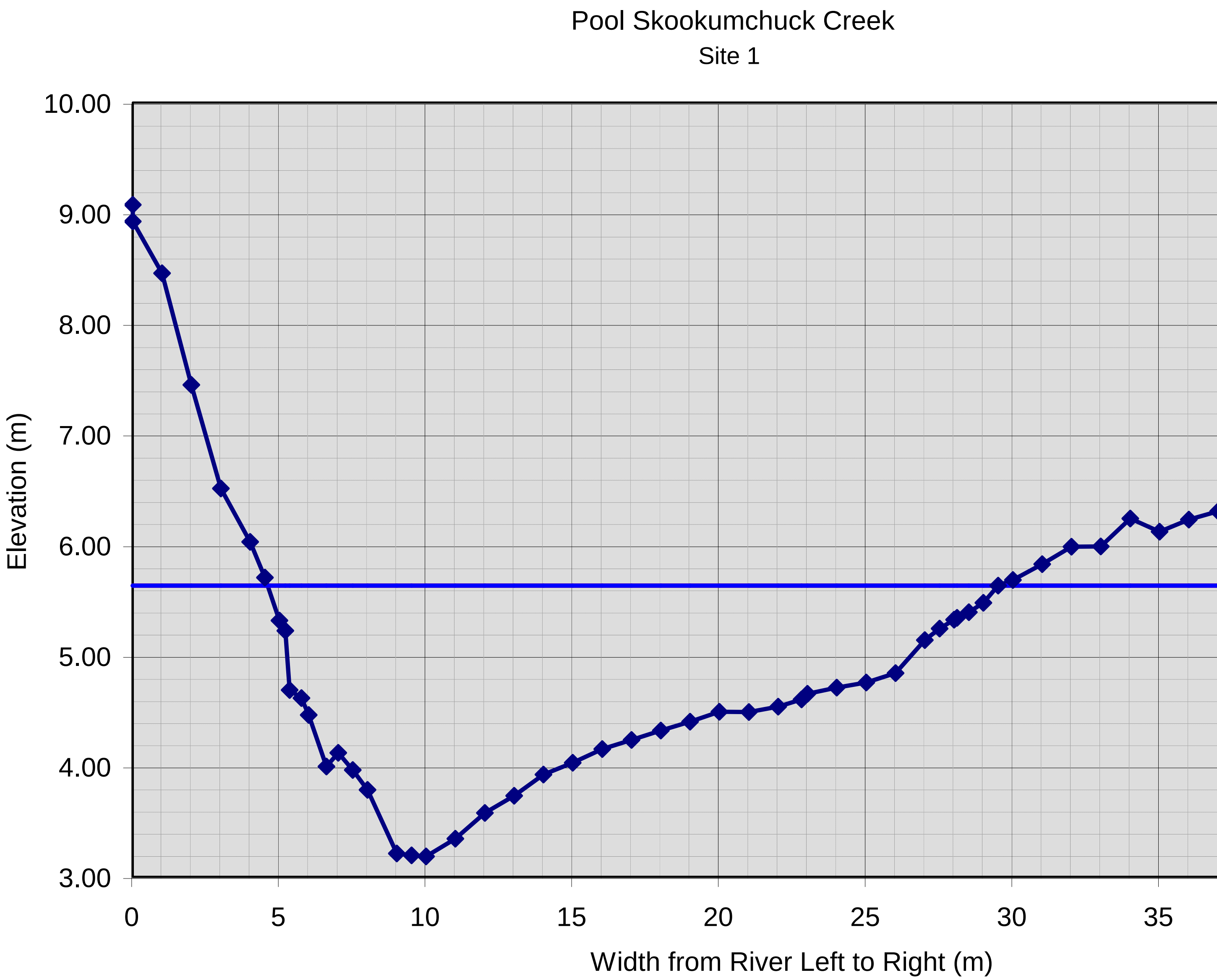
FHAP Channel Survey Data



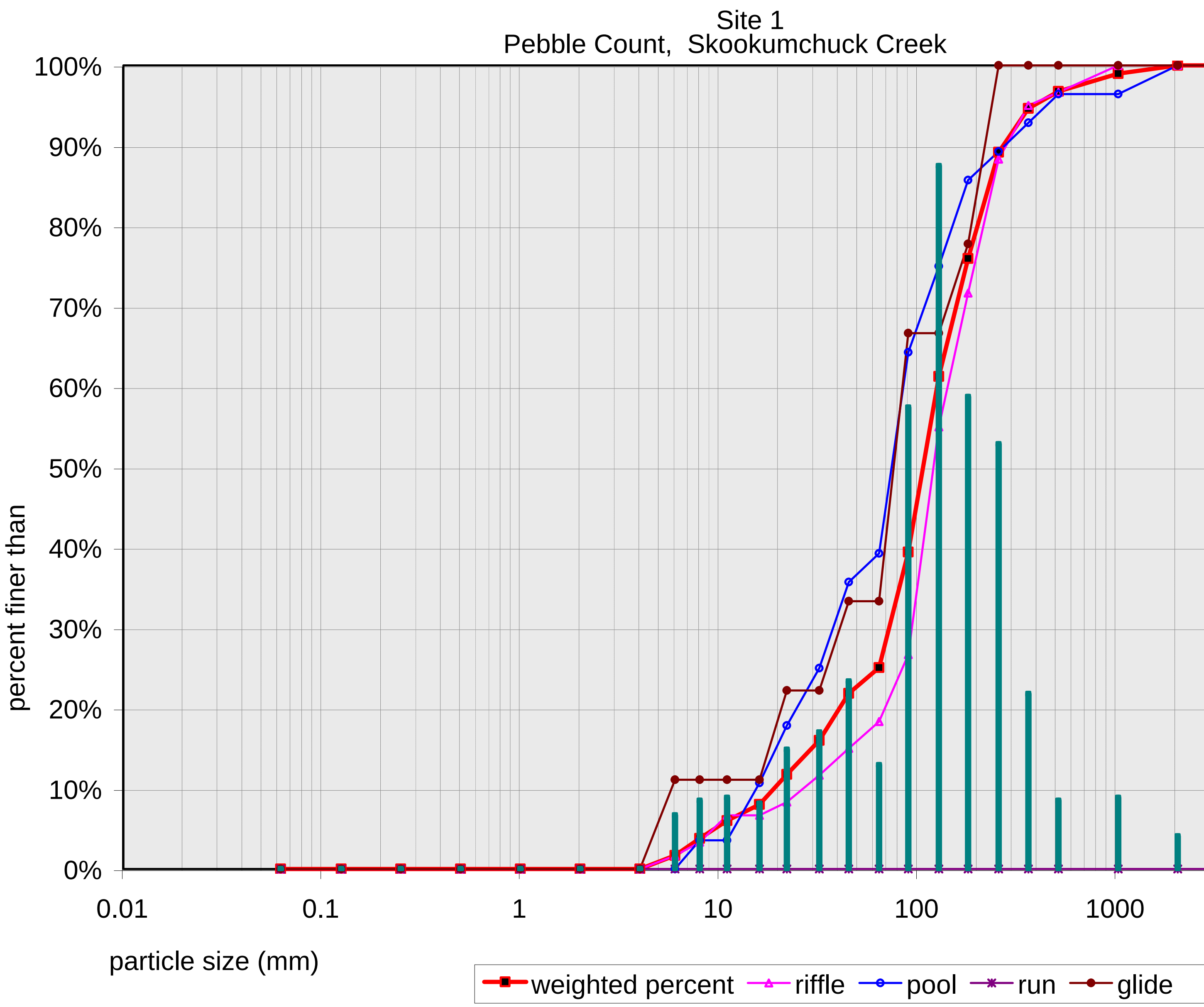
Skookumchuck Creek Upper Kootenay River Site 1 - Tembec Pulpmill (Km 2 FSR)
Elevation (m)
10
9
8
7
6
5
4
3
2
1
0
200
400
600
800
Channel Di
bed
water srf
Terrace
Benchr



Riffle Skookumchuck Creek
Site 1
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
Elevation (m)
-15
-5
5
15
25
35
Width from River Left to Right (m)



Pool Skookumchuck Creek
Site 1
Elevation (m)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
0
5
10
15
20
25
30
35
Width from River Left to Right (m)



Site 1
Pebble Count, Skookumchuck Creek
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
0.01
0.1
1
10
100
1000
particle size (mm)
weighted percent
riffle
pool
run
glide

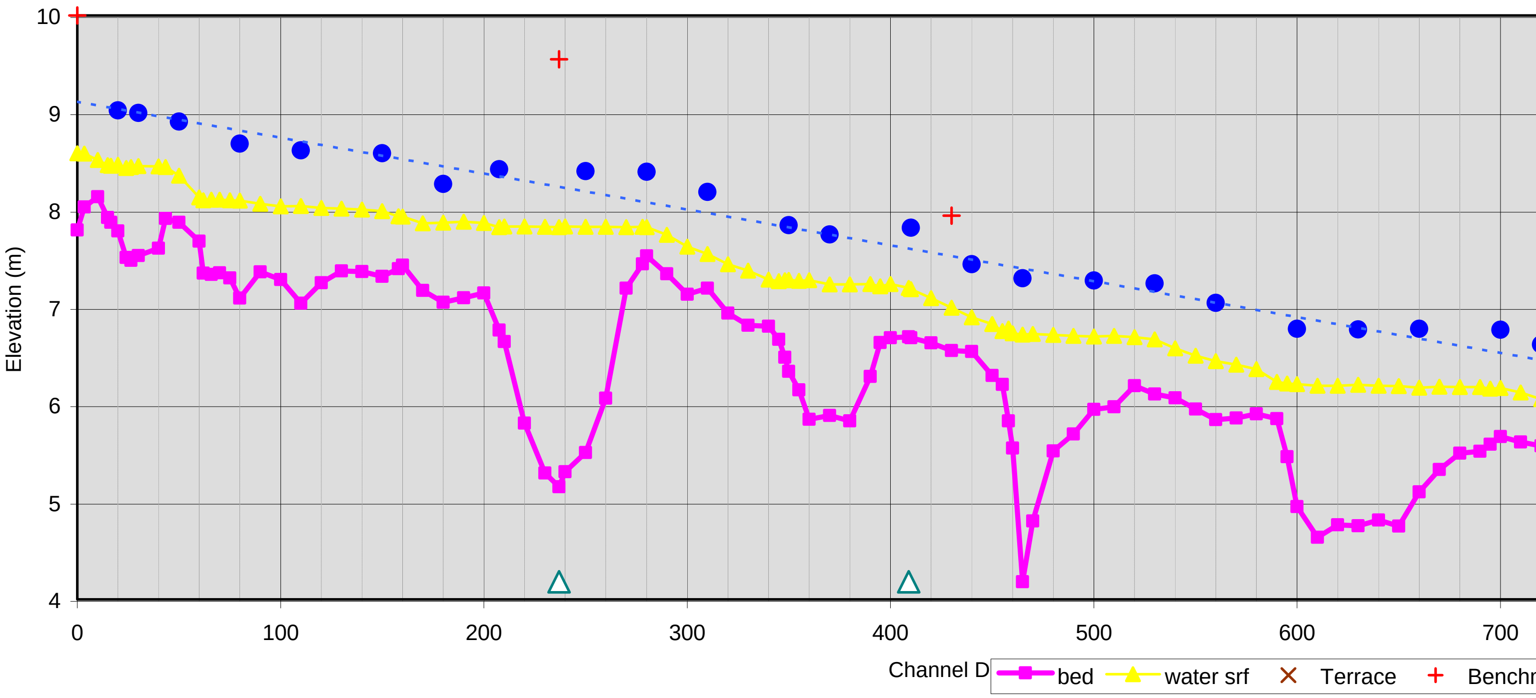
Skookumchuck Creek
Site 1 - Tembec Pulpmill Site (km2)
July 31/03
Scott Cope and Kerry Morris

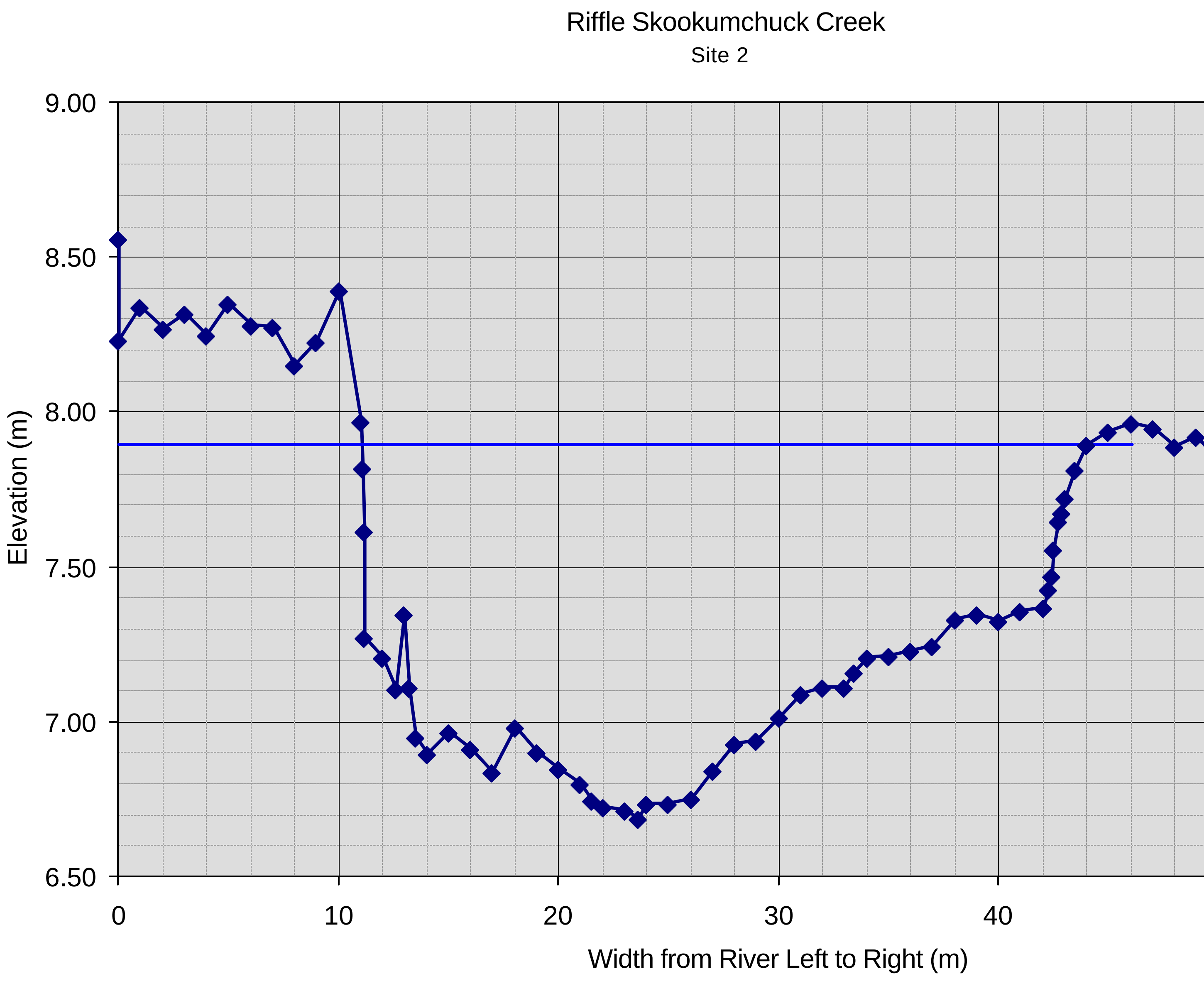
Field (Arbitrary) Elevations (m)

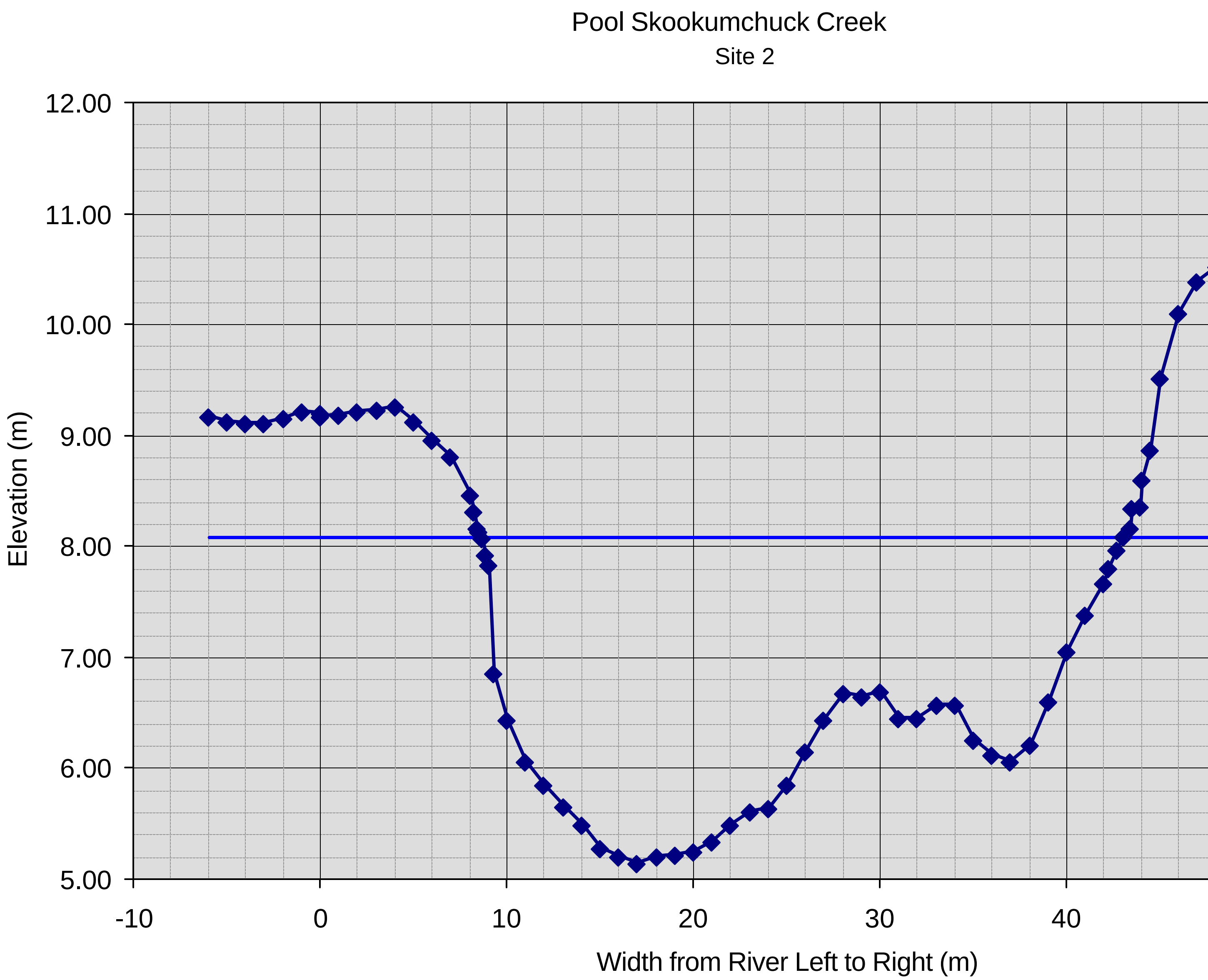
Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1	1.214	11.214		10.000	Lag Bolt Base Tree Rub
TP1	1.508	9.455	3.267	7.947	
TP2	0.734	7.807	2.382	7.073	
TP3	0.694	6.672	1.829	5.978	
TP4	1.265	6.238	1.699	4.973	
TP5	1.196	5.938	1.496	4.742	
BM4			0.902	5.036	Lag Bolt Base Tree Rub
TP6	1.548	5.161	2.325	3.613	
BM5	0.761	5.161	0.761	4.400	Lag Bolt Base Tree Rub
BM5	0.761	5.161			
TP6	2.288	5.902	1.547	3.614	
TP5	1.391	6.134	1.159	4.743	
TP4	2.002	6.974	1.162	4.972	
TP3	1.834	7.811	0.997	5.977	
TP2	2.02	9.096	0.738	7.072	
TP1	3.29	11.238	1.148	7.948	
BM1			1.237	10.001	
			ERROR = 0.001		

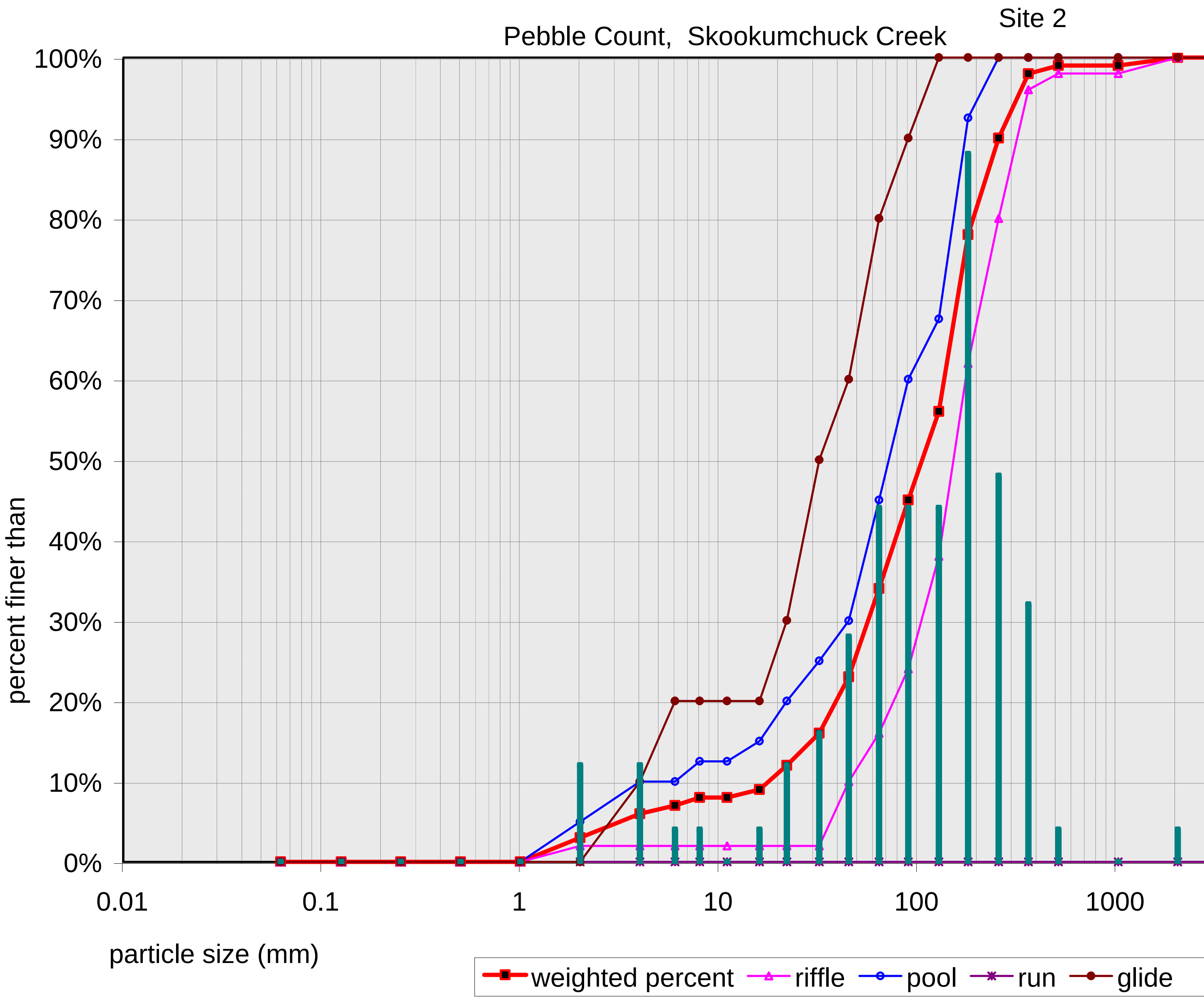
NOTE BM2 = Rbar PIN base of RUB tree at riffle cross section 0 + 440.7 m
Elevation = 7.579 m
BM3 = Rbar Pin base of LUB tree at pool cross-section 0+ 594.5
Elevation = 6.498

Skookumchuck Creek Upper Kootenay River Site 2 - KM 38 Skookumchuck FSR




Riffle Skookumchuck Creek
Site 2
9.00
8.50
8.00
7.50
7.00
6.50
Elevation (m)
0
10
20
30
40
Width from River Left to Right (m)


Pool Skookumchuck Creek
Site 2
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
Elevation (m)
-10
0
10
20
30
40
Width from River Left to Right (m)



Site 2
Pebble Count, Skookumchuck Creek
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
0.01
0.1
1
10
100
1000
particle size (mm)
weighted percent
riffle
pool
run
glide

Skookumchuck Creek
Site 2 - Km 38 Skookumchuck FSR
21-Aug-03
Scott Cope/Kerry Morris

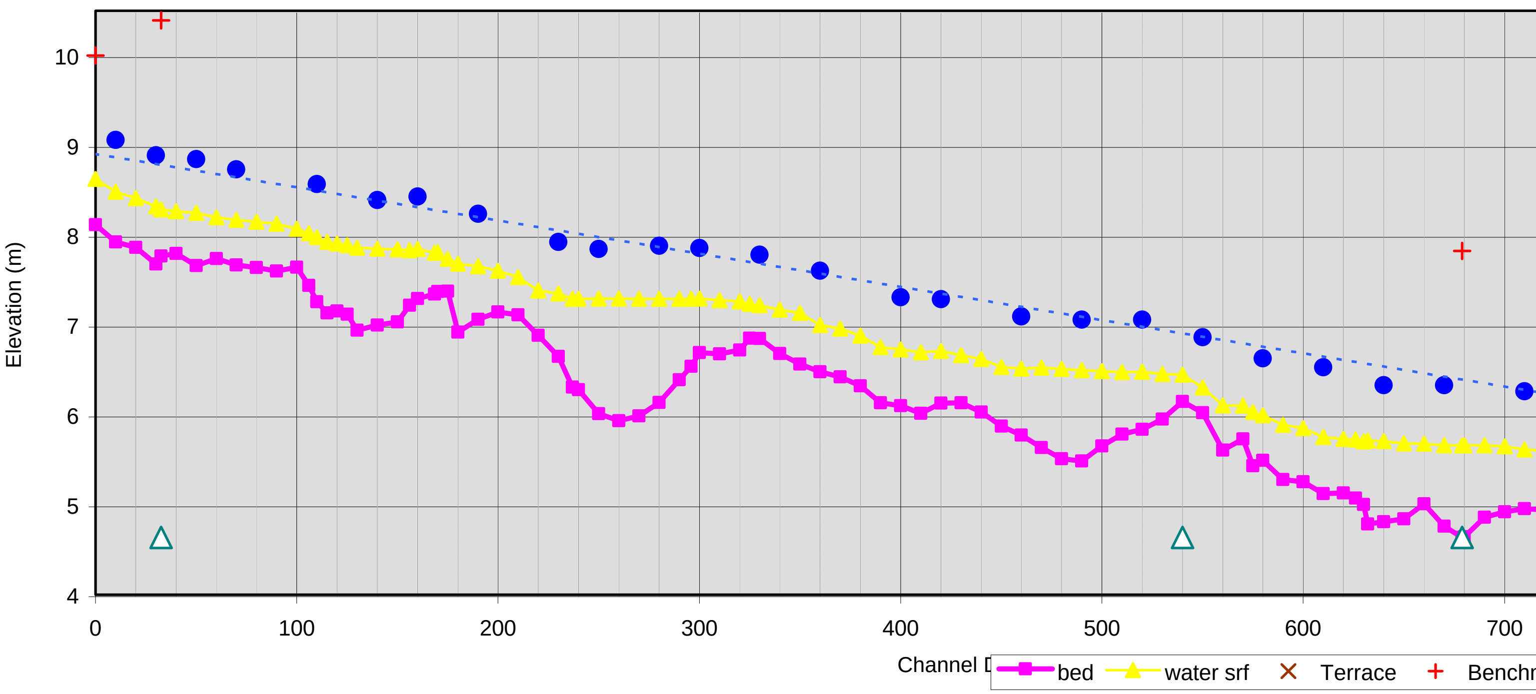
Field (Arbitrary) Elevations (m)

Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1	1.067	11.067		10.000	Lag Bolt Base Tree Rub
RP1	1.452	9.936	2.583	8.484	
RP2	1.18	9.484	1.632	8.304	
RP3	1.083	8.762	1.805	7.679	
RP4	1.329	8.463	1.628	7.134	
RP5	1.747	8.148	2.062	6.374	
RP6	1.861	8.062	1.947	6.201	Lag Bolt Base Tree Rub
RP7	1.668	7.229	2.501	5.561	
BM4			0.345	6.884	Lag Bolt Base Tree Rub
BM4	0.345	7.229		6.884	
RP7	2.485	8.046	1.668	5.561	
RP6	1.800	8.003	1.843	6.203	
RP5	2.106	8.480	1.629	6.374	
RP4	1.583	8.716	1.347	7.133	
BM3	not in loop		0.773	7.943	
RP3	1.85	9.526	1.035	7.681	
RP2	1.67	9.977	1.22	8.306	
RP1	2.57	11.052	1.492	8.485	
BM1			1.051	10.001	

ERROR = 0.001

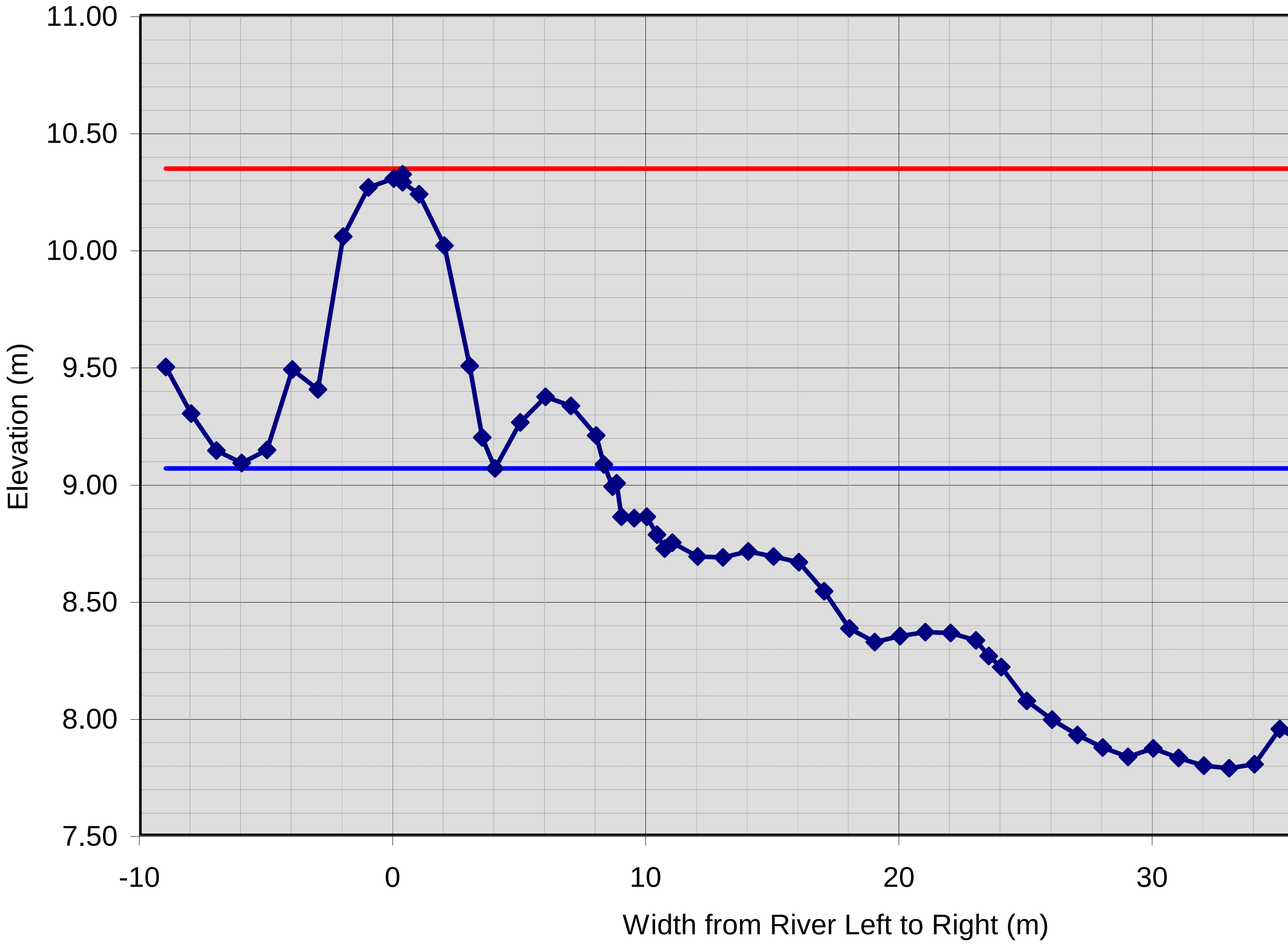
NOTE BM2 = Rbar PIN base of RUB tree at pool cross section 0 + 237 m
Elevation = 9.550 m
BM3 = Rbar Pin base of LUB tree at riffle cross-section 0+ 428
Elevation = 7.943

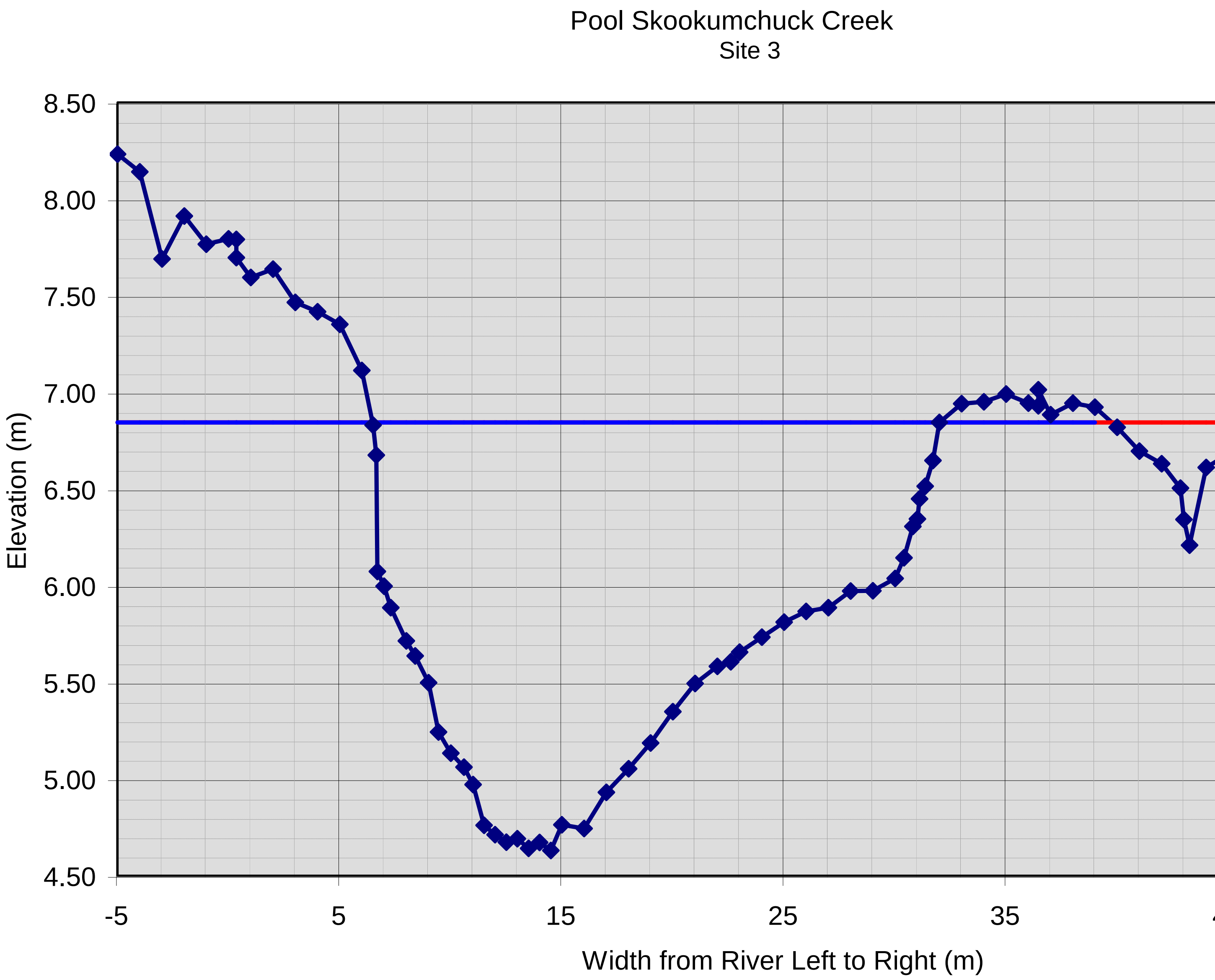
Skookumchuck Creek Upper Kootenay River Site 3 - 42.5 km Skookumchuck FSR

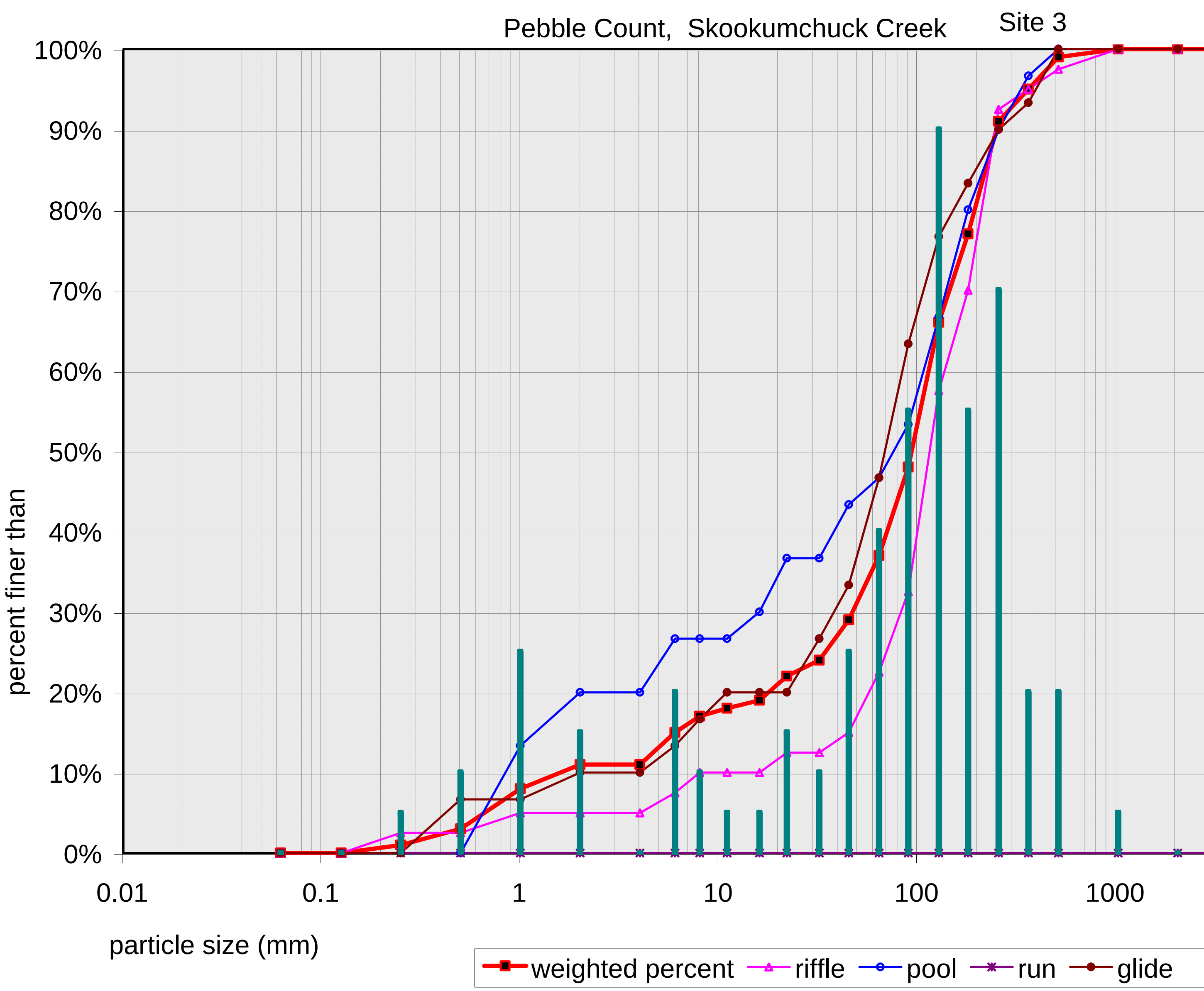


Riffle Skookumchuck Creek

Site 3




Pool Skookumchuck Creek
Site 3
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
Elevation (m)
-5
5
15
25
35
Width from River Left to Right (m)



Pebble Count, Skookumchuck Creek
Site 3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
0.01
0.1
1
10
100
1000
particle size (mm)
weighted percent
riffle
pool
run
glide

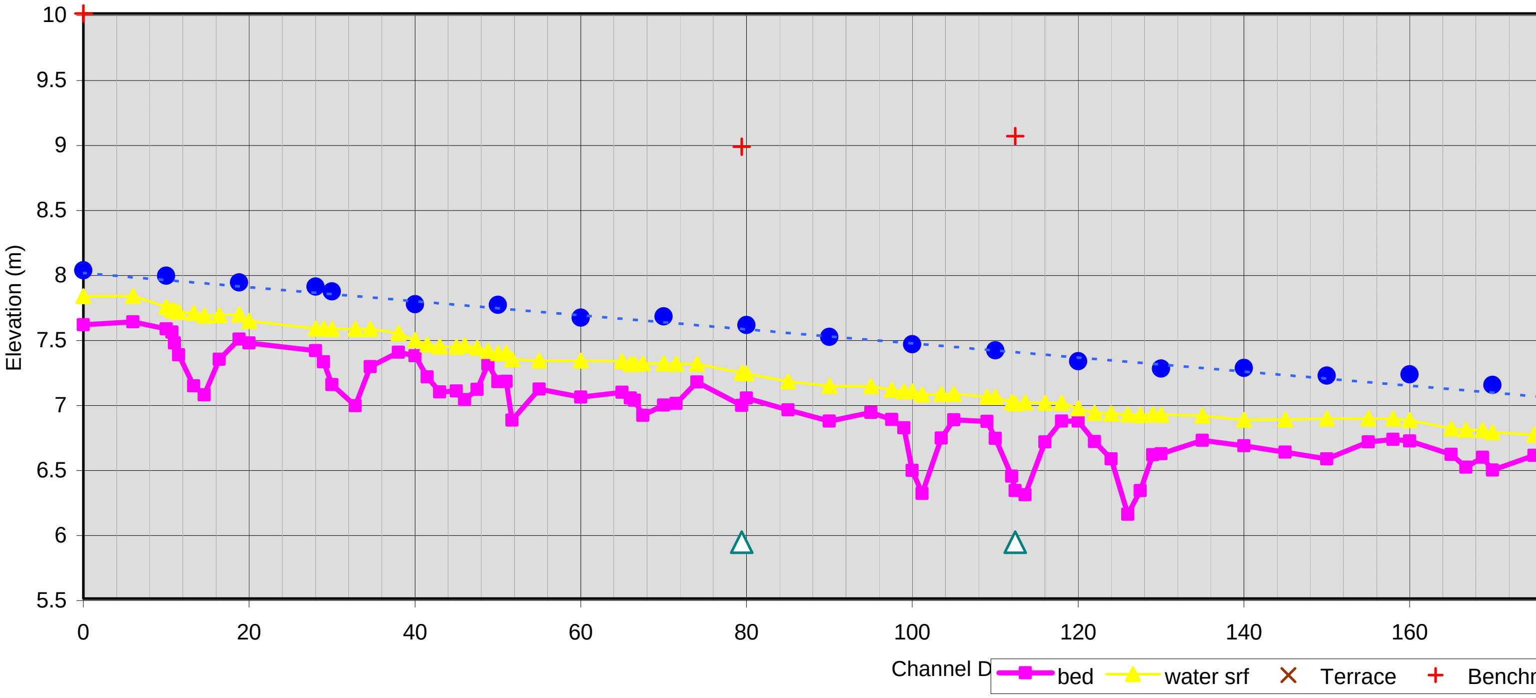
Skookumchuck Creek
Site 3 - 42 Km Skookumchuck FSR
19-Aug-03
Scott Cope/Kerry Morris

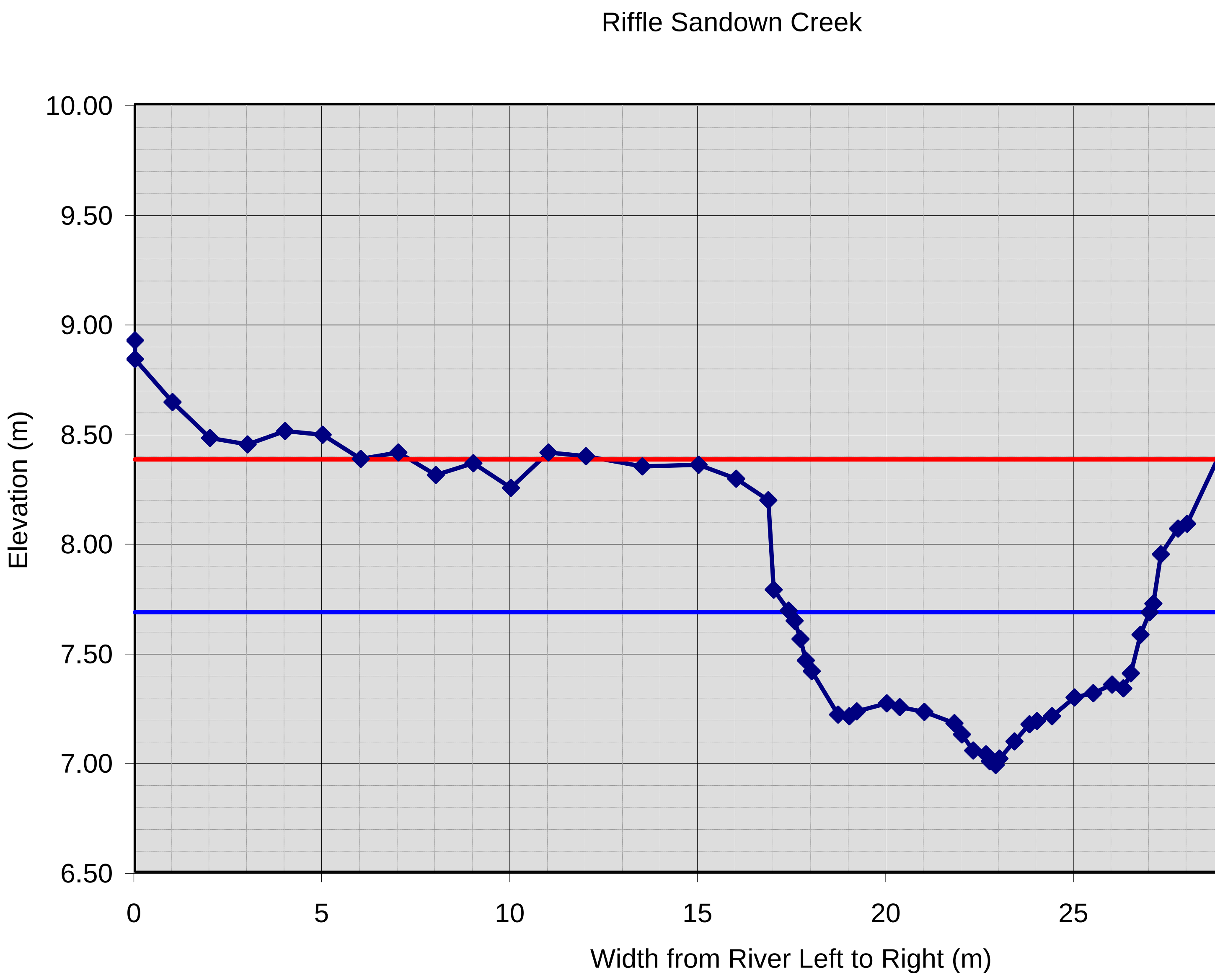
Field (Arbitrary) Elevations (m)

Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1		10.294	0.294	10.000	Lagbolt in base of spruce on LUBat 0m
RP1	1.26	9.464	2.09	8.204	
RP2	1.501	9.009	1.956	7.508	
RP3	0.957	8.095	1.871	7.138	
RP4	0.921	7.432	1.584	6.511	
RP5	1.422	7.253	1.601	5.831	
BM3			0.282	6.971	Lagbolt in base of spruce on RUBat 0+750m
BM3	0.282	7.253		6.971	
RP5	1.610	7.442	1.421	5.832	
RP4	1.59	8.100	0.93	6.512	
RP3	1.859	9.005	0.954	7.146	
RP2	1.888	9.405	1.488	7.517	
RP1	2.156	10.357	1.19	8.215	
BM1			0.358	9.999	
			error =	0.001	

Note: not in loop.
BM2 - riffle cross-section survey pin LUB at 0+32.7m. Elv. = 10.394
BM4 - Pool cross-section survey pin RUB at 0+679 m. Elv. = 7.826

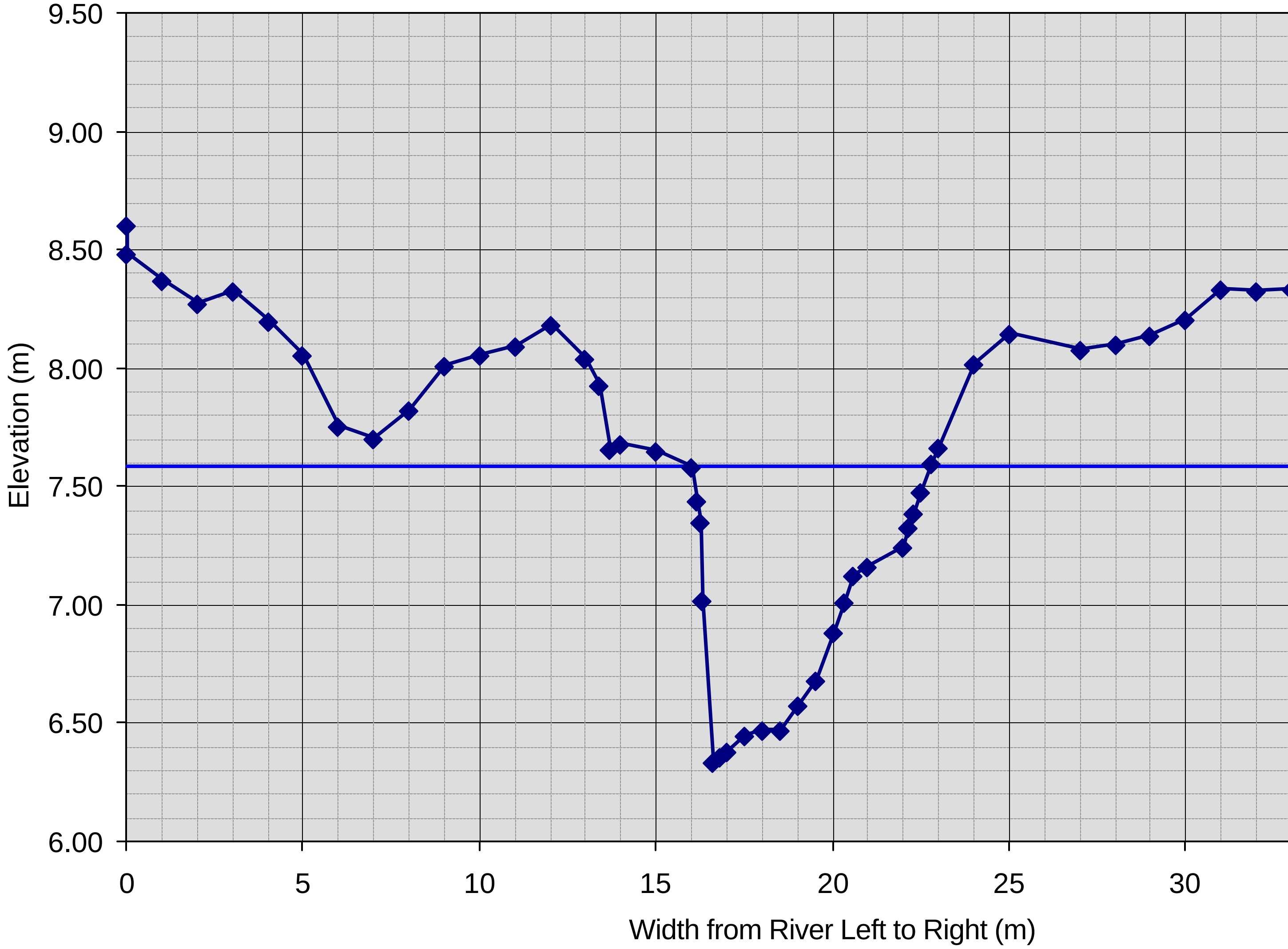
Sandown Creek Skookumchuck Creek Km 30 Skookumchuck FSR

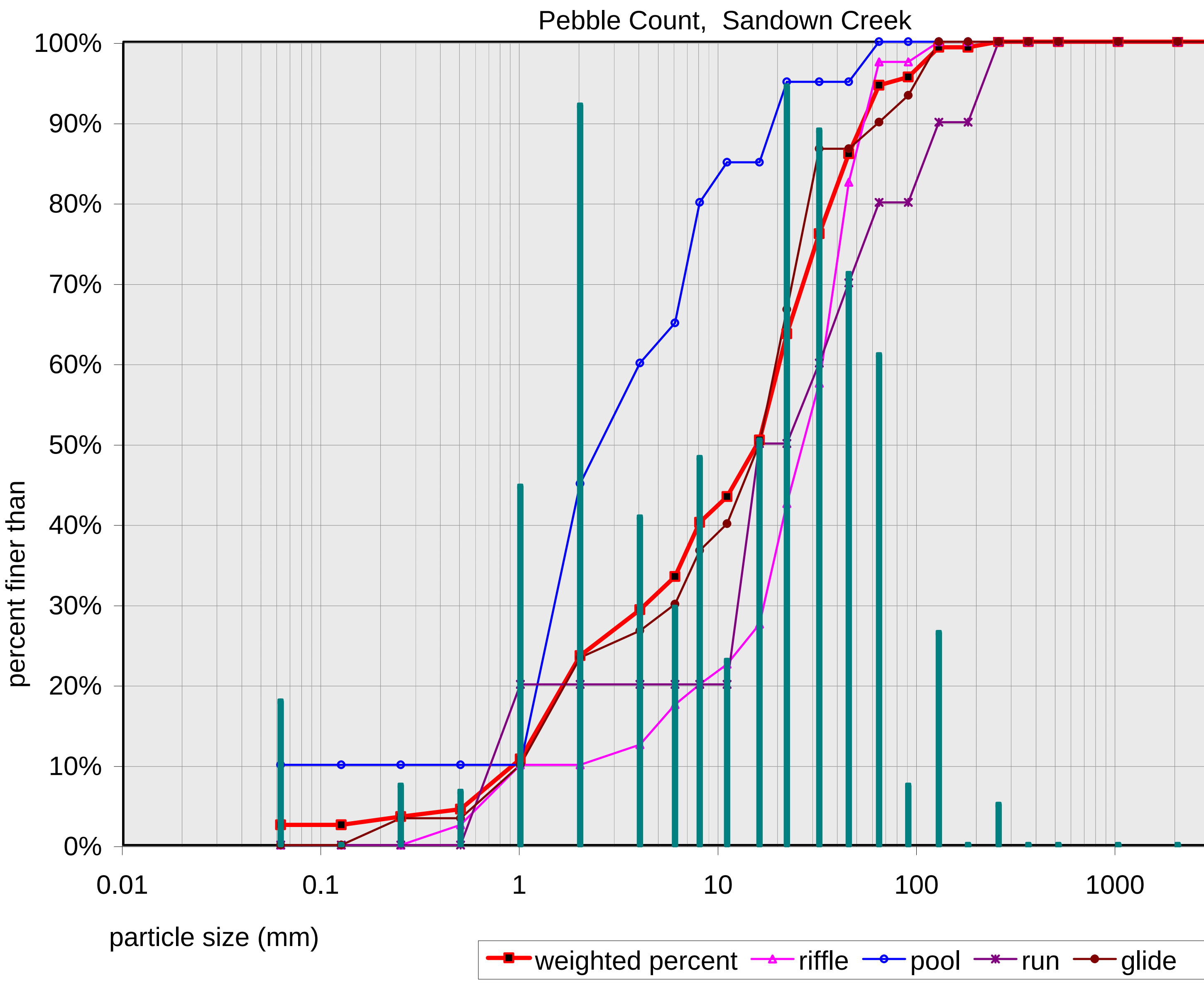




Riffle Sandown Creek
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
Elevation (m)
0
5
10
15
20
25
Width from River Left to Right (m)

Pool Sandown Creek





Pebble Count, Sandown Creek
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
0.01
0.1
1
10
100
1000
particle size (mm)
weighted percent
riffle
pool
run
glide

Sandown Creek
Site 4 - Skookumchuck Creek
12-Aug-03
Scott Cope/Kerry morris

Field (Arbitrary) Elevations (m)

	Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
	BM1	0.28	10.28		10	Lag bolt in pine u/s of start
	TP1	1.138	9.163	2.255	8.025	
	TP2	1.118	8.811	1.47	7.693	
	TP3	1.377	8.532	1.656	7.155	
	TP4	1.58	8.609	1.503	7.029	
	BM4			0.614	7.995	
	BM4	0.632	8.627		7.995	
	TP4	1.516	8.543	1.6	7.027	
	TP3	1.603	8.757	1.389	7.154	
	TP2	1.519	9.213	1.063	7.694	
	TP1	2.311	10.366	1.188	8.025	
	BM1			0.336	10	
Note - Not in loop						
BM2	TP2		8.811		7.693	
	RP1	1.485	9.973	0.0323	8.488	
	BM2			0.998	8.975	
BM3	TP3	2.515	9.67		7.155	
	BM3			0.614	9.056	

Appendix E

Stream Channel Classification (Level II) Form

Stream Channel Classification (Level II) Form

Stream Name:	Skookumchuck Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	641 Km^2		
Location:	Site 1 - Pulpmill Site		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.588463.5529778	(riffle)
		11.588383.5529899	(pool)
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	2-Aug-03

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	31.10	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section (d_{bkf} = A/W_{bkf}).	0.94	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	29.20	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	33.12	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.20	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	121	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	3.90	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	107	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0058	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.38	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C3(1)**	

Stream Channel Classification (Level II) Form

Stream Name:	Skookumchuck Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	442 Km^2		
Location:	Site 2 - km 38 Skookumchuck FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)			11.575451.5536205 (riffle)
			11.575261.5536154 (pool)
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	21-Aug-03

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	33.00	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A/W_{bkf}$).	0.83	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	27.30	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	39.89	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.20	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	123	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	3.73	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	106	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0037	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.69	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C3**	

Stream Channel Classification (Level II) Form

Stream Name:	Skookumchuck Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	419 Km^2		
Location:	Site 3 - km 42.5 Skookumchuck FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.572183.5535065 (riffle)	
		11.572249.5535612 (pool)	
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	19-Aug-03

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	32.50	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A/W_{bkf}$).	0.81	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	26.30	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	40.16	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.30	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or ($2 \times d_{mbkf}$) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	64	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	1.97	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	94	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0036	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.35	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C3**	

Stream Channel Classification (Level II) Form

Stream Name:	Sandown Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	54.7 Km^2		
Location:	Site 4 - upstream of km 30 Bridge Skookumchuck FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.580440.5539829	(riffle)
		11.580444.5539801	(pool)
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	12-Aug-03

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	9.60	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section (d_{bkf} = A/W_{bkf}).	0.43	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	4.10	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	22.48	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	0.70	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	21	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	2.22	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	16	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0064	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.30	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**F4 → C4**	

Appendix F

Reference Reach Data Summary Form

Reference Reach Data Summary Form

Stream Name: Skookumchuck Creek

Location: Site 1 - pulpmill site at Skookumchuck

Channel DIMENSION
Data from Riffle & Pool x-sectional surveys

Bankfull Pool Width (W_{bkfp})	24.90 m	Bankfull Riffle Width (W_{bkf})		31.30 m	
Bankfull Pool Depth (d_{bkfp})	1.31 m	Bankfull Riffle Depth (d_{bkf})		0.93 m	
Bankfull Pool XS Area (A_{bkfp}) (X-Section Data)	32.70 m^2	Bankfull Riffle XS Area (A_{bkf})		29.20 m^2	
Max. Bankfull Pool Depth (d_{mbkfp})	2.40 m	Max. Bankfull Riffle Depth (d_{mbkf})		1.20 m	
Max. Bankfull Pool Depth (d_{mbkfp}) (X-Section Data; Long. Profile Data)	1.75 m (Min.)	2.40 m (Max.)	1.98 m (Mean)		
Ratio: Bankfull Pool Width/Bankfull Riffle Width:				0.80	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:				1.41	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:				1.12	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:		1.88 (Min.)	2.57 (Max.)	2.12 (Mean)	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:		1.20 m		1.00	$Bh_{low}/(d_{mbkf})$
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)				1.81	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)				70	m^3/s

(Lowest Bank Height - measured from thalweg to top of lowest bank, in a riffle section)

Channel PATTERN

	(Min.)	(Max.)	(Mean)	
Meander Length (L_m)	270 m	450 m	340 m	
Radius of Curvature (R_c)	52 m	175 m	101 m	
Belt Width (W_{BLT})	139 m	240 m	176 m	
Ratio: Meander Length/Bankfull Riffle Width	8.63	14.38	10.86	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	1.66	5.59	3.23	(R_c/W_{bkf})
Meander Width Ratio (MWR):	4.44	7.67	5.62	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitundinal Profile Survey

Valley Slope (VS)	0.0079 m/m	Water Surface SLOPE (S)	0.0058 m/m	
	(Min.)	(Max.)	(Mean)	
Riffle Surface Slope (S_r)	0.0075 m/m	0.0081 m/m	0.0079 m/m	
Pool Surface Slope (S_p)	0.0011 m/m	0.0023 m/m	0.0016 m/m	
Glide Surface Slope (S_g)	0.0018 m/m	0.0023 m/m	0.0021 m/m	
Run Surface Slope (S_{run})	0.0062 m/m	0.0115 m/m	0.0083 m/m	
Bankfull Max. Riffle Depth (d_{rmax})	1.10	1.35 m	1.20 m	
Bankfull Glide Depth (d_g)	1.30 m	1.47 m	1.38 m	
Bankfull Run Depth (d_{run})	1.42 m	1.57 m	1.49 m	
Pool Length (P_{length})	35.00 m	106.00 m	66.50 m	
Pool to Pool Spacing ($P_{spacing}$)	120.00 m	320.00 m	238.00 m	
Ratio: Riffle Surface Slope/Water Surface Slope	1.30	1.41	1.37	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.19	0.40	0.28	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.31	0.39	0.37	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	1.07	1.99	1.44	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	1.18	1.45	1.29	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.39	1.57	1.48	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.52	1.69	1.60	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	1.12	3.39	2.12	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	3.83	10.22	7.60	$P_{spacing}/W_{bkf}$

Channel MATERIALS

% Sand & <	0	D_{16}		32	mm
% Gravel	24	D_{35}		81	mm
% Cobble	63	D_{50}		107	mm
% Boulder	11	D_{84}	233 (riffle)	223 (cummulative)	mm
% Bedrock	3	D_{95}		384	mm

Reference Reach Data Summary Form

Stream Name: Skookumchuck Creek

Location: Site 2 - km 38 Skookumchuck FSR

Channel DIMENSION
Data from Riffle & Pool x-sectional surveys

Bankfull Pool Width (W_{bkfp})	34.30	m	Bankfull Riffle Width (W_{bkf})	33.00	m
Bankfull Pool Depth (d_{bkfp})	1.93	m	Bankfull Riffle Depth (d_{bkf})	0.83	m
X-Section Data					
Bankfull Pool XS Area (A_{bkfp})	66.20	m^2	Bankfull Riffle XS Area (A_{bkf})	27.30	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	2.90	m	Max. Bankfull Riffle Depth (d_{mbkf})	1.20	m
X-Section Data					

	(Min.)	(Max.)	(Mean)	
Max. Bankfull Pool Depth (d_{mbkfp}) (Long. Profile Data)	1.65 m	3.35 m	2.43 m	
Ratio: Bankfull Pool Width/Bankfull Riffle Width:			1.04	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:			2.33	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:			2.42	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:	1.99	4.05	2.94 (Mean)	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:	1.20 m		1.00	$Bh_{low}/(d_{mbkf})$

(Lowest Bank Height - measured from thalweg to top of lowest bank, in a riffle section)

Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)	1.30	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)	53	m^3/s

Channel PATTERN

	(Min.)	(Max.)	(Mean)	
Meander Length (L_m)	90 m	366 m	229 m	
Radius of Curvature (R_c)	34 m	92 m	67 m	
Belt Width (W_{BLT})	92 m	165 m	128 m	
Ratio: Meander Length/Bankfull Riffle Width	2.73	11.09	6.94	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	1.02	2.79	2.03	(R_c/W_{bkf})
Meander Width Ratio (MWR):	2.79	5.00	3.88	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitudinal Profile Survey

Valley Slope (VS)	0.0062	m/m	Water Surface SLOPE (S)	0.0037	m/m

	(Min.)	(Max.)	(Mean)	
Riffle Surface Slope (S_r)	0.0035 m/m	0.0096 m/m	0.0063 m/m	
Pool Surface Slope (S_p)	0.0000 m/m	0.0013 m/m	0.0006 m/m	
Glide Surface Slope (S_g)	0.0000 m/m	0.0014 m/m	0.0006 m/m	
Run Surface Slope (S_{run})	0.0028 m/m	0.0184 m/m	0.0088 m/m	
Bankfull Max. Riffle Depth (d_{rmax})	0.99	1.22 m	1.08 m	
Bankfull Glide Depth (d_g)	1.02 m	1.33 m	1.23 m	
Bankfull Run Depth (d_{run})	1.23 m	1.66 m	1.48 m	
Pool Length (P_{length})	40.00 m	85.00 m	59.60 m	
Pool to Pool Spacing ($P_{spacing}$)	112.00 m	215.00 m	149.60 m	
Ratio: Riffle Surface Slope/Water Surface Slope	0.95	2.63	1.71	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.00	0.35	0.16	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.00	0.38	0.17	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	0.78	5.05	2.41	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	1.20	1.47	1.31	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.23	1.61	1.49	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.49	2.01	1.79	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	1.21	2.58	1.81	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	3.39	6.52	4.53	$P_{spacing}/W_{bkf}$

Reference Reach Data Summary Form

Stream Name: Skookumchuck Creek

Location: Site 3 - km 42.5 Skookumchuck FSR

Channel DIMENSION

Data from Riffle & Pool x-sectional surveys

Bankfull Pool Width (W_{bkfp})	25.50	m	Bankfull Riffle Width (W_{bkf})	32.50	m
Bankfull Pool Depth (d_{bkfp})	1.39	m	Bankfull Riffle Depth (d_{bkf})	0.81	m
X-Section Data: Bankfull Pool XS Area (A_{bkfp})	35.40	m^2	Bankfull Riffle XS Area (A_{bkf})	26.30	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	2.20	m	Max. Bankfull Riffle Depth (d_{mbkf})	1.30	m

	(Min.)	(Max.)	(Mean)	
X-Section Data / Long. Profile Data: Max. Bankfull Pool Depth (d_{mbkfp})	1.40 m	2.20 m	1.81 m	
Ratio: Bankfull Pool Width/Bankfull Riffle Width:			0.78	(W_{bkfp})/(W_{bkf})
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:			1.72	(d_{bkfp})/(d_{bkf})
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:			1.35	(A_{bkfp})/(A_{bkf})
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:	1.73	2.72	2.24	(d_{mbkfp})/(d_{bkf})
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:	1.30 m		1.00	Bh_{low}/(d_{mbkf})

(Lowest Bank Height - measured from thalweg to top of lowest bank, in a riffle section)

Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)	1.23	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)	51	m^3/s

Channel PATTERN

	(Min.)	(Max.)	(Mean)	
Meander Length (L_m)	310 m	500 m	390 m	
Radius of Curvature (R_c)	74 m	210 m	148 m	
Belt Width (W_{BLT})	187 m	520 m	329 m	
Ratio: Meander Length/Bankfull Riffle Width	9.53	15.38	12.00	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	2.27	6.46	4.55	(R_c/W_{bkf})
Meander Width Ratio (MWR):	5.76	16.00	10.12	(W_{BLT}/W_{bkf})

Channel PROFILE

Data from Longitundinal Profile Survey

Valley Slope (VS)	0.0049	m/m	Water Surface SLOPE (S)	0.0036	m/m

	(Min.)	(Max.)	(Mean)	
Riffle Surface Slope (S_r)	0.0054 m/m	0.0114 m/m	0.0073 m/m	
Pool Surface Slope (S_p)	0.0002 m/m	0.0013 m/m	0.0008 m/m	
Glide Surface Slope (S_g)	0.0009 m/m	0.0034 m/m	0.0021 m/m	
Run Surface Slope (S_{run})	0.0049 m/m	0.0098 m/m	0.0068 m/m	
Bankfull Max. Riffle Depth (d_{rmax})	1.05	1.19 m	1.15 m	
Bankfull Glide Depth (d_g)	1.10 m	1.22 m	1.15 m	
Bankfull Run Depth (d_{run})	1.26 m	1.34 m	1.30 m	
Pool Length (P_{length})	35.00 m	258.00 m	134.00 m	
Pool to Pool Spacing ($P_{spacing}$)	112.00 m	223.00 m	169.00 m	
Ratio: Riffle Surface Slope/Water Surface Slope	1.50	3.14	2.03	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.06	0.35	0.23	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.25	0.94	0.58	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	1.36	2.70	1.89	(S_{run}/S)
Ratio: Bankfull Max. Riffle Depth/Bankfull Riffle Depth	1.30	1.47	1.41	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.36	1.51	1.42	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.55	1.66	1.60	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	1.08	7.94	4.12	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	3.45	6.86	5.20	$P_{spacing}/W_{bkf}$

Channel MATERIALS

% Sand & <	11	D_{16}		7	mm
% Gravel	26	D_{35}		59	mm
% Cobble	54	D_{50}		94	mm
% Boulder	9	D_{84}	252 (riffle)	215 (cummulative)	mm
% Bedrock	0	D_{95}		362	mm

Reference Reach Data Summary Form

Stream Name:	Sandown Creek
Location:	Site 4 - km 30 Skookumchuck FSR

Channel DIMENSION
Data from Riffle & Pool x-sectional surveys

Bankfull Pool Width (W_{bkfp})	6.80	m	Bankfull Riffle Width (W_{bkf})	9.60	m
Bankfull Pool Depth (d_{bkfp})	0.72	m	Bankfull Riffle Depth (d_{bkf})	0.43	m
Bankfull Pool XS Area (A_{bkfp}) (X-Section Data)	4.90	m^2	Bankfull Riffle XS Area (A_{bkf})	4.10	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	1.20	m	Max. Bankfull Riffle Depth (d_{mbkf})	0.70	m

	(Min.)	(Max.)	(Mean)	
Max. Bankfull Pool Depth (d_{mbkfp}) (X-Section Data / Long. Profile Data)	0.80 m	1.20 m	1.00 m	
Ratio: Bankfull Pool Width/Bankfull Riffle Width:			0.71	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:			1.69	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:			1.20	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:	1.87	2.81	2.34	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:	1.20 m		1.71	$Bh_{low}/(d_{mbkf})$
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)			2.68	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)			11	m^3/s

(Lowest Bank Height - measured from thalweg to top of lowest bank, in a riffle section)

Channel PATTERN

	(Min.)	(Max.)	(Mean)	
Meander Length (L_m)	64 m	81 m	72 m	
Radius of Curvature (R_c)	12 m	14 m	13 m	
Belt Width (W_{BLT})	13 m	20 m	17 m	
Ratio: Meander Length/Bankfull Riffle Width	6.67	8.44	7.54	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	1.20	1.48	1.34	(R_c/W_{bkf})
Meander Width Ratio (MWR):	1.35	2.08	1.72	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitudinal Profile Survey

Valley Slope (VS)	0.0081	m/m	Water Surface SLOPE (S)	0.0064	m/m

	(Min.)	(Max.)	(Mean)	
Riffle Surface Slope (S_r)	0.0077 m/m	0.0224 m/m	0.0128 m/m	
Pool Surface Slope (S_p)	0.0005 m/m	0.0030 m/m	0.0017 m/m	
Glide Surface Slope (S_g)	0.0015 m/m	0.0026 m/m	0.0020 m/m	
Run Surface Slope (S_{run})	0.0093 m/m	0.0193 m/m	0.0138 m/m	
Bankfull Max. Riffle Depth (d_{rmax})	0.53	0.70 m	0.58 m	
Bankfull Glide Depth (d_g)	0.55 m	0.74 m	0.65 m	
Bankfull Run Depth (d_{run})	0.75 m	0.80 m	0.78 m	
Pool Length (P_{length})	6.00 m	22.30 m	9.60 m	
Pool to Pool Spacing ($P_{spacing}$)	10.00 m	76.00 m	31.00 m	
Ratio: Riffle Surface Slope/Water Surface Slope	1.21	3.52	2.01	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.07	0.47	0.27	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.23	0.41	0.32	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	1.46	3.03	2.17	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	1.24	1.64	1.36	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.29	1.73	1.52	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.76	1.87	1.83	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	0.63	2.32	1.00	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	1.04	7.92	3.23	$P_{spacing}/W_{bkf}$

Channel MATERIALS

			(riffle)	(cummulative)	
% Sand & <	24	D_{16}		1	mm
% Gravel	71	D_{35}		6	mm
% Cobble	5	D_{50}		16	mm
% Boulder	0	D_{84}	45	42	mm
% Bedrock	0	D_{95}		74	mm

Appendix G

Velocity Calculations

Velocity Calculations

Date	2-Aug-03		**Gage Number**	08NG051	
Stream	Skookumchuck Creek Site 1 (pulpmill site)				

Input Variables			**Output Variables**		
Bankfull Cross Sectional Area (A_{BKF})	29.20	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.94	m
Bankfull Width (W_{BKF})	31.1	m	Wetted Perimeter (WP) (~(2*D_{BKF})+W_{BKF})	33.0	m
D84 (Riffle)	233	mm	D84 (mm/1000)	0.23	m
Bankfull Slope (S)	0.00578	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.89	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	3.80	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	6.2	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.039	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.82	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.22	m/s
Velocity: u=u*(2.83+5.7logR/D84)	1.37	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.0389	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.80	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	69.5	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	2.38	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = $(R^{1/6} \times 0.0926)/(1.16 + 2\log(R/D_{84}))$	0.0391

Velocity Calculations

Date	21-Aug-03		**Gage Number**	08NG051	
Stream	Skookumchuck Creek Site 2 -FSR Km 38				

Input Variables			**Output Variables**		
Bankfull Cross Sectional Area (A_{BKF})	27.30	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.83	m
Bankfull Width (W_{BKF})	33.0	m	Wetted Perimeter (WP) (~($2*D_{BKF}$)+W_{BKF})	34.7	m
D84 (Riffle)	253	mm	D84 (mm/1000)	0.25	m
Bankfull Slope (S)	0.00365	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.79	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	3.11	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	5.8	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.041	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.26	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.17	m/s
Velocity: u=u*(2.83+5.7logR/D84)	0.95	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.0415	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.24	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	52.6	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	1.93	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = ($R^{1/6}$ x 0.0926)/(1.16 + 2log(R/D_{84}))	0.0415

Velocity Calculations

Date	19-Aug-03		**Gage Number**	08NG051	
Stream	Skookumchuck Creek Site 3 - FSR Km 42.5				

Input Variables			**Output Variables**		
Bankfull Cross Sectional Area (A_{BKF})	26.30	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.81	m
Bankfull Width (W_{BKF})	32.5	m	Wetted Perimeter (WP) (~(2*D_{BKF})+W_{BKF})	34.1	m
D84 (Riffle)	252	mm	D84 (mm/1000)	0.25	m
Bankfull Slope (S)	0.00362	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.77	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	3.06	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	5.7	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.041	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.23	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.17	m/s
Velocity: u=u*(2.83+5.7logR/D84)	0.93	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.0419	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.21	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	50.5	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	1.92	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = ($R^{1/6}$ x 0.0926)/(1.16 + 2log(R/D_{84}))	0.0416

Velocity Calculations

Date	12-Aug-03		**Gage Number**	08NG051	
Stream	Sandown Creek Site 4 - FSR Km 30				

Input Variables			**Output Variables**		
Bankfull Cross Sectional Area (A_{BKF})	4.10	m^2	Bankfull Mean Depth D_{BKF} $= (A_{BKF}/W_{BKF})$	0.43	m
Bankfull Width (W_{BKF})	9.6	m	Wetted Perimeter (WP) $(\sim(2*D_{BKF})+W_{BKF})$	10.5	m
D84 (Riffle)	45	mm	D84 (mm/1000)	0.05	m
Bankfull Slope (S)	0.00636	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.39	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	8.72	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	8.5	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.030	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.42	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: u*=(gRS)$^{0.5}$	0.16	m/s
Velocity: u=u*(2.83+5.7logR/D84)	1.28	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.0261	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.64	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	11	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	2.68	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = $(R^{1/6} \times 0.0926)/(1.16 + 2\log(R/D_{84}))$	0.0261